SCHOOL SCIENCE AND MATHEMATICS

VOL. IX. NO. 7 CHICAGO, OCTOBER, 1909 WHOLE NO. 72

HOW MAY THE TEACHING OF MATHEMATICS BE MADE MORE EFFICIENT?

BY DAVID EUGENE SMITH, LL.D.,

Professor of Mathematics in Teachers' College, Columbia University.

In contributing to this discussion on the teaching of mathematics, I should like to call attention to the tendencies to make the teaching of mathematics less efficient as well as to those that give promise of improving the work.

In connection with all agitation for reform there is invariably a tendency to inefficiency. This is one of the penalties of reform, apparently necessary, but to be curtailed as much as possible. History is so full of examples of this fact that illustrations are quite unnecessary. Some of the tendencies to inefficiency in the present laudable efforts at reform are as follows:

1. The tendency to cut the heart out of mathematics in certain ill-considered efforts to make it more attractive. Mathematics has always been one of the most interesting subjects in the curriculum, and largely because it required effort and carried with it the inspiration of having mastered some definite thing. Any tendency to lessen that effort, and to remove the feeling of tangible grip on something definite, is a tendency to inefficiency.

2. The tendency to ignore the lessons of a tried and proved psychology while seeking very properly for new psychological truths. The teaching world has found that both efficiency and interest have resulted from leading a pupil to see a truth and then from having him apply that truth time and again until there wore itself a subtle charm in the nerve cells of his brain that fixed the truth with some degree of permanence. The means employed were not always the best—probably were never the best, and upon these we are improving; but the principle

has not yet been superseded by giving little touches of a subject here and there in such concrete cases as may be forced to seem natural. The arrangement of a course in mathematics solely on the basis of applications suited to the child's age has thus far made for inefficient teaching. This has carried with it the neglect of abstract work for reasons that have failed to stand the only scientific tests that have been applied, and this has proved a further tendency to inefficiency.

3. The tendency to believe that every new thing, however sanely suggested, is all good, has made for inefficiency. One phase of this danger is seen in the graphic work of algebra. Those who suggested it and first used it in algebra did so in order to accomplish a definite and well-considered purpose. Those who have transcended this purpose, and have forced in a lot of graphic work that had no definite reason for being in high school algebra, have consumed time to a relatively unworthy purpose and have to that extent stood for inefficiency in the essentials. We are pretty sure to have the same result in connection with the introduction of the valuable idea of "function." Every thinking teacher sees its value, but with its sane introduction is bound to come a tendency to inefficiency through the waste of time on a lot of nonessentials.

4. The tendency to believe that the work of a brilliant teacher of mathematics is to be followed by everyone, is in the direction of inefficiency. A brilliant teacher can make a poor plan produce good results, as all the history of "method" proves. Here is the danger of inefficiency in the laboratory method; even in its extreme form it can be used with little danger by a brilliant teacher, but it is bound to make for inefficiency, unless guarded more than is likely to be the case, in ordinary hands. The same is true in the matter of correlating of mathematical subjects among themselves and with other lines of work, in which every live teacher is interested; with all the potential good comes a marked tendency to inefficient work through the very lack of definiteness, through the lack of sufficiently dwelling upon single principles to fix them in mind, and through the sacrifice of mathematics to the subjects to which it may possibly be applied. I have usually found that professors of engineering in colleges were positive in their feeling that students who come from the traditional course in mathematics are more efficient than those who have come from a course "enriched" by applica-

tions to engineering and related topics—and this I say in spite of the fact that I myself advocate this very enrichment, I hope with reasonable limitations.

On the other hand the tendencies to efficiency are most hopeful to-day. The very dangers above mentioned are the results of these tendencies in which we are all so interested. The elimination of obsolete applications, the recognition of the proper balance of abstract and concrete, the removing of barriers where they ought to be removed and maintaining them as proper dividing lines in other cases, the hopeful tendency to arrange our high school curriculum on a psychological basis as we are arranging that in the elementary school, and the awakening interest in what the rest of the world is doing—all these are tendencies to efficient teaching that cannot be overrated.

CORRELATION OF ALGEBRA AND GEOMETRY.

By Edith Long,

High School, Lincoln, Nebraska.

Since it is generally conceded that the subjects of mathematics should be correlated among themselves and as far as possible with physics, the only question under discussion is as to the best method of bringing them together in order to give the pupil power of reasoning (which is the primary object of the study), and at the same time give him such facility in the mechanical operations that he may not be handicapped in future applications in engineering courses.

It seems to me that the method that is being advocated by some, to continue to teach the algebraic processes for the entire first year with a few statements of geometric truths (unproved) as a basis for problem work, does not meet the demands of the case. The trouble now with the first year work, as it is generally taught, is that it is too full of statements and rules which the beginner is supposed to master and use. The method proposed, to introduce geometric statements without proof, only taxes further the memory power, without adding either to the scope of reasoning or interests.

There are few who have studied and examined the mental processes of the pupil of the first year who are not convinced that only the very best (and I doubt that it is true even of

these) do any amount of reasoning with the abstract symbols of algebraic language. The reasoning must be done about the concrete, in the language of the pupil, and this language translated into symbol language, if symbols are to be used with meaning. To this end is the present tendency among a thinking class of teachers to make the problem work predominate in the algebra. To bring the matter down to the point, the greater part of the reasoning of algebra is to be derived from the solution of the problem. It is held, then, by this class of teachers, that first year pupils can reason, but the reasoning must be done by means of the solution of problems. Why should this style of reasoning be held suitable to the younger pupil and the simpler reasoning of the proof of exercises in the beginning of geometry tabooed? One cannot help but feel that it is the prejudice of years of precedent and not the conclusions of thoughtful experiment. The ninth grade pupil can do such geometric reasoning as is called for in the beginning of the geometry with more facility than he can do problems in algebra, and he takes more pleasure in doing it.

There is a great advantage in introducing the geometric reasoning early in the course of mathematics. Through its training, the insistence on the "reason why" becomes a habit with pupils and distinctly lessens the tendency to solve an example "any way to get the answer." The geometry not only furnishes material for problems, but by means of geometric proof of the truths, gives additional interest to problems.

The introduction of geometry in the first year pushes the heavier work of the algebra to the second and third years and gives to this part of the work longer time without necessitating the lowering of the standard of work given, something that is necessary for a first year pupil. Furthermore, it enables a course in mathematics to be built up in such a way that the pupil may see and feel the close relation of algebraic and geometric thought.

The geometry of areas and the geometric representation of factoring; the book of circles in geometry followed by the loci of points and the immediately related subject of simultaneous equations and their graphic representation; the book of similar figures in geometry and the ratio and proportion of algebra, to say nothing of the numerous problems leading to quadratic equations, are but suggestions of the possibilities of a carefully planned course in mathematics.

I cannot close these remarks without a word of caution to the teacher who would try the plan of correlating. Take care to adapt the method of teaching as well as the course.

Do not hand the ninth grade pupil a geometry and assign to him a lesson to be prepared to recite in class the next day. This is a poor method for starting geometry in any year. The average high school pupil is not a born geometrician. He must be led gradually into the new language and method of thinking. Assign little home preparation until he has shown some familiarity with his new thoughts. If he has had some easy problem work in algebra preceding the starting of the geometry, give him problems for his home work based on the truths brought out in his geometry. This will keep him in touch with his algebra and not distract his mind from the work in hand. As to the plan of recitation I know of nothing so helpful to a teacher as a study of the chapter entitled "The Instruction in Mathematics" in "The Teaching of Mathematics in Prussia," written by Dr. Young.

THE SYLLABUS METHOD OF TEACHING PLANE GEOMETRY.

By Eugene R. Smith,

Head of Mathematics Department, Polytechnic Preparatory School, Brooklyn, N. Y.

So many statements of an absolutely contradictory nature have been said or written about the syllabus method, that it is next to impossible for one who is attempting to form an opinion as to its merits to judge what its exact application is.

At one meeting held a short time ago a speaker who was to discuss "How to Choose a Text-book in Mathematics," remarked that he might better take a certain man who was present, off in a corner and read the paper to him; for, as far as he could judge, there was no one else present who believed in using a text-book at all.

On the other hand, another speaker at a meeting not long after attacked the syllabus method with great heat, saying among other things, "To expect a boy of fourteen or thereabouts to evolve from his inner consciousness in one year all the geometrical discoveries of the great minds of over twenty centuries is the height of folly."

This paper is written with the hope of clearing up to some degree this misunderstanding of the aims and the working of the method. I might say in beginning that I have been in close touch with the syllabus movement for the last ten years, a good share of which I have spent in a school where the method has been in use for twenty-five or more years, and that I have never known a teacher, who had given it a fair and intelligent trial, to be willing to return to the text-book method.

In the first place, the syllabus method requires a teacher rather than an instructor, for its success depends largely upon the teacher's judgment of both subject and pupil. Its object is not to make each pupil *discover* every truth of plane geometry for himself, but to help each pupil to *think to the limit of his ability*. If a pupil can discover only the most elementary steps of reasoning, the teacher's questions to that pupil must be graded by that fact. Much of the value of the syllabus method depends upon the fact that in so far as a person discovers any fact for himself, just so far does that fact become a part of the person. Furthermore, the experience of the race in discovering truths becomes the heritage of each of us; it is easy for us to rediscover the things which have been common thought for our ancestors, although the first discovery may have been made only after long research. This is partly true because of our increased knowledge of how to attack, but there seems to be a psychological side to it as well.

Briefly stated, the syllabus method is as follows:

The pupil is supplied with a syllabus, which should contain the definitions with some discussion of them, the statements of the propositions, exercises, and explanations of the methods of attack. It may also contain sample proofs, but in general omits the proofs entirely. The proofs of the theorems are worked out by the pupils, under the guidance of the teacher. When this work is done in class, it is done either by the class as a whole guided by the teacher's questions (which is the method best employed with the more difficult theorems), or by the pupils individually, either at the boards or at their seats, but here again under the watchful eye of the teacher, who questions the weaker ones and keeps in continual touch with all. When the work is done for preparation, the pupils are supposed to apply the methods learned in class to the assigned propositions. After the pupils have worked out a proof, either by class discussion or by

working alone, each pupil makes a formal written demonstration and hands it in to the teacher. This proof is corrected by the teacher and is filed in the pupil's note book which eventually becomes a complete geometry text which has been prepared by the pupil. It is evident that the function of the teacher is *to direct thought,* rather than to instruct the pupils on the matter of the subject. However the recitations may be carried on, there is much discussion of the uses of the theorems studied; they are arranged in classes according to their conclusions, and much oral work is done, with the double intention of bringing the pupils to think quickly and clearly, and of introducing all the different viewpoints regarding the subject under examination.

I will give a typical class discussion with the teacher's questions, and the answers expected from the class in parentheses. These answers would sometimes be called for from individual pupils, sometimes from the class as a whole; when the point is especially important the teacher might ask the question, and then wait until every pupil in the class had signified that he knew the answer, before calling for it to be given. As this theorem comes very early in the geometry, in the order which I am assuming, the questions are more detailed than is necessary later. As a matter of fact, most pupils can discover this proof without questioning, but it is such an excellent example of the class method that I have chosen it for illustration.

STATEMENT.—If two sides of a triangle are equal, the opposite angles are equal.

What kind of a figure shall I draw? (a triangle.) Any special kind? (isosceles.) In this triangle ABC, which two sides will we call equal? (BC=CA.) What is to be proved? (angle A= angle B.) Why these angles? (they are opposite the sides given equal.) In general, what kind of a conclusion do we want? (angles equal.) What ways of proving this are known? (right angles are equal, straight angles are equal, perigons are equal; complements, supplements, or explements of equal angles are equal; vertical angles are equal; corresponding angles of congruent triangles are equal.) Are the angles A and B known to be right angles, straight angles, or perigons? (no.) Have we any equal angles of which these angles might be complements, supplements, or explements? (no.) *Some discussion of these points in reference to the figure is likely to be necessary.* Are the angles vertical? (no.) Upon what method must the proof

depend? (congruent triangles.) Why? (it is the only one left.) Are the angles A and B in two different triangles at present? (no, in one triangle.) Is it possible for them to be in two different triangles? (yes, if one or more lines are drawn.) What must be used in proving this theorem? (the given, BC=CA.) How will it be used? (in proving triangles congruent.) Then what must be in each of the triangles to be formed? (BC and angle B in one; CA and angle A in the other.) From where must a line be drawn so as to form two triangles having these parts? (from C.) In how many ways can we draw a line so that we will know that it is fixed? (four: through two points, bisecting an angle; perpendicular to a line, either at a point, or from a point.) How many of these things can a line be drawn to do? (one.) How shall we decide which way to draw the line? (draw it so as to help get the triangles congruent.) What is needed to make two triangles congruent? (two sides and the included angle, two angles and the included side.) Which way is more likely to be used here? (two sides and the included angle.) Why? (requires less knowledge about the angles, which is what we are trying to find.) If any line is drawn through the triangle from C, how many equal parts have the triangles? (two, the sides given equal, and the common line.) What more is needed? (the included angle.) Which is it? (the angle between the given line and the common side in each triangle.) Which of the ways to draw a line will give this angle? (bisector of angle C.) Does this line meet AB? (yes; a line between the arms of an angle meets any transversal of the arms of the angle.) Let us call the point X. State definitely which angles are equal. (angle BCX=angle XCA.) Do we now know that angle A=angle B? (yes.) Why? (corresponding angles of the congruent triangles BCX and XCA.) How do we know that they are corresponding? (they are each opposite the common side CX.) *The entire proof is then called for in logical form, either from one pupil, or by steps from different pupils, after which the discussion is continued.* For what will this theorem be used? (to prove angles equal.) Then this must be added to our ways of proving angles equal? (yes.) Is that the only way in which it is possible to use this theorem? (no, it can be used to reason from by the converse and contraposite methods.) State its contraposite. (If two angles of a triangle are unequal, the opposite sides are unequal.) Is this statement true? (yes.) Why? (The contraposite

of a true statement is always true.) State the converse of the theorem proved. (If two angles of a triangle are equal, the sides opposite are equal.) Is this known to be true? (no.) Why? (the converse is known to be true only when the statements cover all possibilities.) What other case, then, must we investigate? (If two sides of a triangle are unequal.)

The class then proceeds with the new investigation.

The natural objection, "What if the pupils do not answer as the teacher wishes?" has undoubtedly occurred to anyone to whom this method is new. It is the business of the teacher to do each day's work so that the answers required are the ones that pupils will think of most naturally; for example, if the teacher has thoroughly discussed with the class the determination of lines, and the way to tell whether parts of triangles are corresponding or not, the answers to the questions on those points will be almost certain. There are many places where the pupils will see wrong viewpoints and will start off on side issues; and one test of a good teacher is his ability to judge whether the point in question is worth following up, and if not how best to show that it is a false clue and so not worth wasting time upon.

To sum up, the method is a combination of questioning in class and of encouraging the pupils to work out for themselves all that is within the range of each one. It places emphasis upon individuality, aims for originality, but does not despise the pupil who can reason but falteringly. It needs more time at the beginning of the subject, but more than makes up for it by increased speed toward the end. Above all, it appeals to the pupil, for it never expects him to take a certain method of proof on trust, because someone else discovered that the method in question would give the result, but it always attempts to show the underlying reason which compels each step.

PROGRESS IN CUBA.

With the beginning of the present fiscal year the Republic of Cuba established a Bureau of Information, President Gomez appointing Leon J. Canova, an American newspaper man, who has resided in Cuba eleven years and has a wide acquaintance with the Island, as its director.

Parties wishing information of any nature concerning Cuba can obtain same, free of charge, by writing to Leon J. Canova, U. and I. Bureau, (Utility and Information Bureau), Department of Agriculture, Commerce and Labor, Havana, Cuba.

ON THE PLACE OF MATHEMATICS IN MODERN EDUCATION.[1]

By Prof. D. N. Lehmer,

University of California.

We are not very far away from the time when learned men communicated with each other for the most part in Latin. A glance at the journals of the learned societies of half a century ago reveals the important part that this language had to play in the development of all modern science. It is not to be wondered at, therefore, that the impression arose that there was something magical in the study of Latin. "Men who are educated speak Latin: therefore men who speak Latin are educated," was the easy process of reasoning from a proposition to its converse. Man is a worshiping animal and the educator who tries to get along without a belief in the existence of an all perfect, all sufficient, all embracing Study finds himself regarded as little better than an infidel.

Educators of to-day are ready to admit that the Great Elixir which is to transform our raw and ignorant youth into philosophers and statesmen has not been found in Latin. This is not to say, however, that the search for the Philosopher's Stone has been discontinued. Every year some pedagogic alchemist comes forward confidently with something new for us to try. Half of modern education seems to consist in tearing down old idols and the other half in setting up new ones. Upon all this hubbub the mathematician has looked down with calm superiority. He has not been given to any superstitions regarding the supreme importance of Latin or Greek. He is ready to admit that there is, and indeed can be no one subject which is a *sine qua non* in education, with the exception, of course, of mathematics.

Josh Billings says that the reason that a dog has fleas is to keep him from brooding over the fact that he is a dog. In these latter days the mathematician has had a flea or two put in his ear that is well calculated to disturb his dream of dominion. Witness the following remarks from a speech by Prof. G. F. Swain of the Massachusetts Institute of Technology. "I am disposed to assign a comparatively low value to mathematics

[1]Read in part before the Mathematics Section of the California Teachers' Association, at San José, December 31, 1908.

simply as a training, aside from its applications. I have not observed that students trained in this subject are able to *reason* better than students who have ignored mathematics. * * * I have not observed that students of mathematics are as a rule more *accurate* than other students, or that a training in the branches of mathematics above arithmetic leads to *accuracy.* * * * Mathematics does not train the *observation;* neither does it train the *imagination,* except in the geometrical branches."[2]

Sic transit gloria mundi. Nevertheless we who are about to die salute you. We ask for the chance to say why sentence of death should not be passed upon us. We think, too, that we can give a reason for the hope that is within us of a resurrection.

Two charges were brought against Socrates: one, that he did not believe in the gods received by the state; the other, that he corrupted the youth by teaching them not to believe in those gods. The charges against the mathematician are not dissimilar. If there is a god in which the state devoutly believes at the present time, it is the god of business. The mathematician has been discovered from time to time worshiping at the altars of strange deities. He has been detected teaching things for which there is little or no use in "practical" life. There is an old story that Euclid once rebuked a student who enquired what he was to gain from a certain theorem. "Give him a penny," said the teacher to one of his slaves, "since he must be making some profit from this study." It is questionable whether Euclid could have been so saucy if he had been depending for his salary upon a school board unanimous in demanding that every thing taught to the young men in his charge should have some demonstrable connection with the problem of making a living.

Now I for my part am free to confess that I never try to teach my classes how to make a living. I have seen so few teachers who seemed to know how, that I am inclined to think they would not make very competent instructors in this subject. I fear my own classes would be justified in saying to me, "Physician, heal thyself!" Let it be assumed, however, that this is the business of the teacher, and alas for the teacher that admits it for an instant, (alas for the land where the teacher is not chiefly concerned with something vastly more important,

[2]Professor G. F. Swain, Massachusetts Institute of Technology, Science N. S. Vol. XXVIII No. 713, August 28, 1908.

the building of character), assume, I say, that this monstrous doctrine is true and that the rich man, honest or dishonest, is the most valuable output of any school, the question still remains, "Will a rigid exclusion from the course of every thing not immediately available for practical life, best accomplish even this sordid end?"

"Shall we teach this or that fact?" "Is this or that illustration best for a mining engineer?" "What shall we prescribe for a bank clerk in the way of examples?" These are the burning questions of the day. Almost every teacher has a list of facts, the failure to know every one of which is fatal for the student. The newer the science the more intolerant the makers of these educational creeds. Among the sciences of an older and riper culture, such as mathematics, these confessions of faith are happily giving place to a healthy freedom of thought and method. Those who will not make their own creeds must often, however, submit to creeds made by others, hence in almost every school of "applied" science the teacher of mathematics is supplied with a carefully selected list of the things he is to "give" to his students.

When we take the trouble to look at things as they really are in education how absurd all such lists and schedules are! Do they not all presuppose the old "sausage case" theory of education: that whatever goeth into a man stayeth there? The teacher who prides himself on his ability to compel a class to absorb all of the facts listed in So and So's text-book would do well to get his class together three months after the final examination and see how much of it remains. One of the hardest lessons for a teacher to learn is that a boy is not a sausage case, but a real live alimentary canal with all of the whims and idiosyncracies of alimentary canals in general.

Personally, I have long ago ceased worrying for fear I should not be able to drag my class over precisely the assigned course. I have learned from experience that the actual content of a course is of very little importance. I am sometimes asked by my students what possible use could the engineer make of this or that theorem. I am always ready to admit frankly that there is only the remotest chance that as engineers they will ever make the slightest immediate use of anything they may learn in my classes or in any other professor's classes. If a graduate of five years' standing could pass one of my examinations in sophomore calculus I should know at once why he had made such

a failure in his work as an engineer. What are we trying to do? Are we trying to teach the boy how to use his head or do we think it is our duty to provide him with a ready made solution for every problem in life? Is it really worth our while as architects to try to estimate the exact value of every two-by-four theorem that goes into the scaffolding? Do we expect the scaffolding to remain always about the building? How difficult for us to divest ourselves of the superstition, as old as the history of education, that this or that study will certainly equip us for any emergency in life! Teachers of engineering as well as teachers of mathematics should realize that apart from the mental training involved in mastering them, the facts with which they deal are of very little importance to the student in after life. To quote from a paper by Mr. C. F. Scott, consulting engineer of the Westinghouse Electric and Manufacturing Company: "After all, it is not so much abstract courses as it is with men with which we have to do; it is not mere knowledge of facts or facility in mathematical manipulation, but it is training. The young man is to be developed, his native individuality is to be the basis, he is to increase, not only his knowledge, but his powers and the ability to use them. It is not mathematical skill so much as mathematical sense, or mathematical common sense which is wanted. With pure mathematics as a science we have no quarrel and little affiliation."

It will be objected that following up this theory of education one fact is as good as another for educational purposes since all are quickly forgotten. Also that there is no advantage in examples and illustrations taken from everyday experience over those taken from fairy tales. To the first objection I reply, that it does not follow that because I do not permanently retain every scrap of food which I swallow, and that because sooner or later every trace of what I have eaten is eliminated from the body, that it therefore makes no difference what kind of food I use. Some facts have no juice in them, no nourishment. Some are useful for this purpose, some for that. Some facts are like coffee and pickles, good to whet the appetite for more nourishing diet. There are few foods that are not actually injurious to some individuals. How hopeless, then, to expect a text-book writer to include in his book precisely what will be digestible for each member of a class of fifty, especially when good food is so easily spoiled in the cooking. O, these teachers that are always discontented with the text-book!

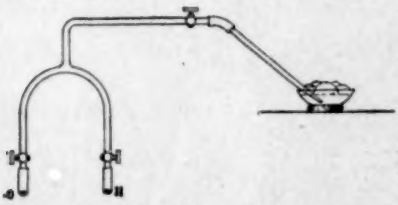
As to the advantage of examples and illustrations taken from everyday experiences over those very remotely connected with practical life, I freely admit that if the purpose of an example or of an illustration is "To equip the student with weapons for the great fight for existence," there is no advantage. One weapon is as good as another if all are discarded long before the student reaches the battle ground. An illustration, as I understand it, is a kind of parable. It is intended to exhibit a principle in a form that engages the attention. The greatest user of parables that the world has ever known drew his materials from the fields, the sheep folds, the fisherman's hut, not, as I take it, because of any intrinsic importance in these materials themselves, but because they were the nearest at hand and demanded the least effort on the part of the disciples to apply to the fundamental principles in question. What teacher can tell in advance what examples will be best for a given class? To require a teacher of mathematics always to use this or that particular illustration of a certain principle is to tie him hand and foot. I do not understand how a teacher can live in a school where he has no individual choice in the matter of what he shall present to his classes. It is significant that much of the complaint as to inadequate preparation for the engineering work comes from such schools. Any attempt to exalt the theorem over the proof is in the wrong direction. I had rather a student should know how to prove one theorem than to state fifty. All things considered, the examples taken from the life around us are easiest to use, but this may not be the case in any particular class and the teacher should be left absolutely free to prescribe for particular cases. If he cannot use anything that is not in the text prescribed he degenerates into a police officer. It is not surprising that under such conditions the results have disappointed the engineer as well as the mathematician. The teacher of engineering is your true homœopathist in regard to mathematics, not only in the minuteness of the dose, but in his faithful adherence to the formula. "Similia similibus curantur." To a student suffering with a bad bilious attack caused by too many undigested facts he would prescribe more facts. "The trouble is," he says, "that the course is not made practical enough." "Too much pure theory." "Not enough connection made with everyday life," etc., etc.

For my part I am not surprised that the schools of engineering have not succeeded in finding on the spur of the moment a better method of training in reflection and reasoning than was ever known to the ancients. I am surprised that the scheme of reducing the time spent in the study of mathematics has not worked worse mischief. It does not pay to be in too much of a hurry in anything that involves growth. It is perfectly possible to "give" a class in a very short space of time all of the facts of a mathematical nature that they will ever need as engineers. The process is about of as much consequence so far as mental training is concerned as if you had taken them into a drug store and had them memorize the labels on the bottles. Why do we delude ourselves into thinking that if we are memorizing something about points and lines that something magical in the way of training must ensue!

The mathematician, then, stands for the supreme importance of the Relation over the Fact. This is his argument why sentence of death should not be passed upon him. He believes that those schools in which mathematics is considered as nothing but a tool to work with will be barren of great scientists and of great engineers. He believes that to the great scientist, or to the great engineer it is no more a tool than his eye or his hand. This belief constitutes his hope for a resurrection.

PRODUCTION OF DETONATING GAS.

With the aid of a Hofmann's Apparatus for decomposing water one can easily prepare detonating gas, by connecting the curved branches of a tube, as in figure, with the two glass tips of the Hofmann Apparatus. The right angle branch of the tube is also connected by a piece of rubber tubing with a stop-cock. To the stop-cock is also attached a longer rubber tube ending in glass tube drawn to a fine point. On passing an electric current through the apparatus, O and H are evolved, and by opening the cocks the gases mix forming detonating gas. The glass point is dipped into a soap solution in a small dish, the other stop-cock opened and the gas mixture enters the soap solution forming bubbles. After removing the glass tip from the soap solution the bubbles may be ignited.—*Periodische Blaetter.*



APPARATUS FOR INSTRUCTION IN GEOGRAPHY AND STRUCTURAL GEOLOGY.

By Professor William Herbert Hobbs,

University of Michigan.

III. The Interpretation of Geologic Maps.[1]

The first number of this series[2] of papers has treated of a method of giving instruction in the interpretation of topographic maps by the aid of comparatively simple laboratory apparatus. This apparatus has since been considerably improved[3] and is manufactured for sale. The second paper of the series[4] proposed slight modifications of the usual laboratory tables and the use of simple apparatus to represent outcroppings of rock in their true attitudes and positions with relation to the earth and to one another. The present paper is an extension of the use of this apparatus in an attempt to give students some knowledge of the real character and meaning of geologic maps—an extension which experience in the laboratory indicated was highly desirable and less difficult of accomplishment than had before been supposed. As described in the following pages this method has now been put into practice with large classes of students of elementary geology with very marked success.

The demand upon the imagination in the preparation of a geologic map. Even in elementary courses in geology it is highly desirable to install some fundamental notion of the significance of a geologic map. On a large scale the attempt is now being made through the Geologic Folio to present local geology in an attractive form to the less technically educated, and those who have pursued an elementary course in geology will naturally essay to read and comprehend the maps which are so generously placed in their hands. Most geologic maps are, however, somewhat complicated documents, and it is the writer's opinion that the average student of geology acquires at best but a hazy notion of the relationships which connect an elaborately colored map with the district it is supposed to represent. The visual resemblance between the map and the district, we must admit, is small; and the tax upon the imagina-

[1] Read before the Association of American Geographers at Baltimore, December, 1908.

[2] This journal, October, 1908.

[3] New Laboratory Methods for Instruction in Geography. The Journal of Geography. Vol. 7, January, 1909, pp. 97-104.

[4] This journal, November, 1908.

tion is too great for any one who has not himself carried out field studies. Both because the expanse of territory which is included in a geologic map is large, and because of the unimpressiveness of the salient geologic elements (the composition and attitude of outcrops, it is often difficult for even the experienced worker to gain a comprehensive general view of the areal and structural relationships involved.

There are, moreover, some areas within the district mapped concerning which it is only possible to conjecture the distribution and the attitudes of the formations, though there are others in which all is revealed as though in an open book. The geologic map has made it appear that the structure of the one area is as clearly revealed as that of the other. How is the student to learn that the maker of the map has by modern conventions been forced to mingle inextricably his fact and his theory? Only through an objective study of the subject can he discover the real meaning of the geologic map. The few students who go on to advanced studies and become professional geologists will eventually acquire this knowledge from their field studies. Can we by any means supply some of the knowledge to the average student? In other words, can the subject be given sufficient objectiveness and comprehensiveness in the laboratory? This is the question which we have tried to answer.

The various types of rock require outcrop blocks of several forms. For the purpose of setting forth objectively the actual facts upon which a geologic map is based, it is necessary to enlarge somewhat the conventional elements in the form of outcrop blocks. To those already described for the representation of the sedimentary rock types,[5] we must add others for the massive or igneous rocks; and it must be possible to indicate a difference between outcrops of abysmal types such as granite, and those of lava flows, and those also of the relatively narrow dikes. To fit the massive structure of the abysmal and surface igneous types, the convention of a drum-shaped block has been adopted, the block of the granite type being thicker than that of the effusive rock. Each of these blocks has a stout wooden peg one-fourth inch in diameter, which projects perpendicularly from the center of its lower surface and fits into a hole in the desired position upon the table (See Fig. 1).

[5]Cf. Article II of this series in the issue of this journal for November, 1908.

For igneous rocks which have filled fissures in the form of dikes, it is necessary to indicate the observed direction of the dike, since this is usually revealed at the outcrop. For this mode of occurrence, therefore, another form of outcrop block is necessary and the convention adopted appears in the long narrow blocks of Fig. 1. In order to maintain this block in a definite direction upon the table, a bolt and a wing-nut fastening is used, as in the outcrop blocks which represent the sedimentary rock types.

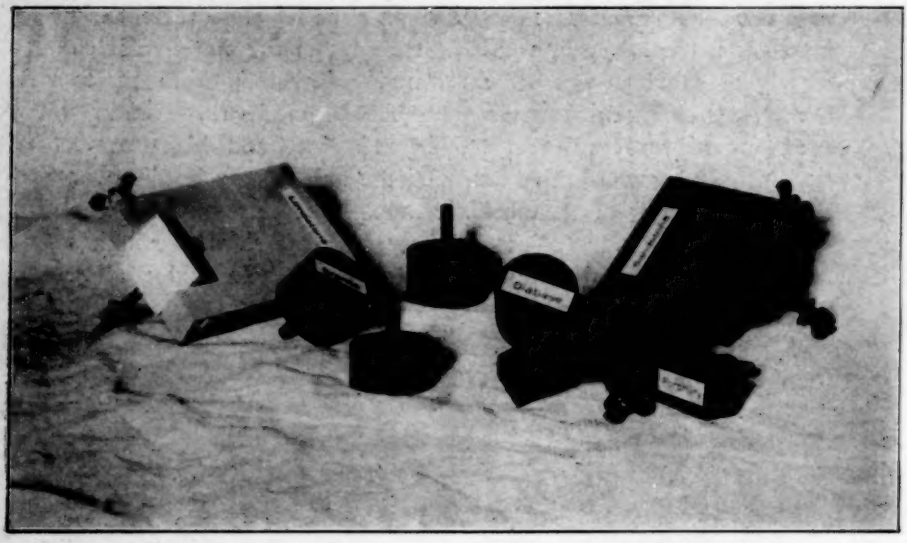


FIG. 1. OUTCROP BLOCKS REPRESENTING VARIOUS SEDIMENTARY AND IGNEOUS ROCK TYPES.

Each of several tables in the laboratory is given over for the time being to a special problem in areal geology, and is thus made to represent a rectangular section of the surface of the earth as many miles long and wide as there are sections one foot square in the length and width respectively of the table. A convenient table for the purpose is eight sections in length and four in width.

Description of a sample table. In the area represented by the table shown in Fig. 2 there are three series of sedimentary rock formations which are separated by unconformities. The oldest of the sedimentary series, here represented as a sandstone, has been thrown into a series of pitching folds, and is

intruded by a batholite of granite. The next younger sedimentary series—a limestone with a basement layer of con-

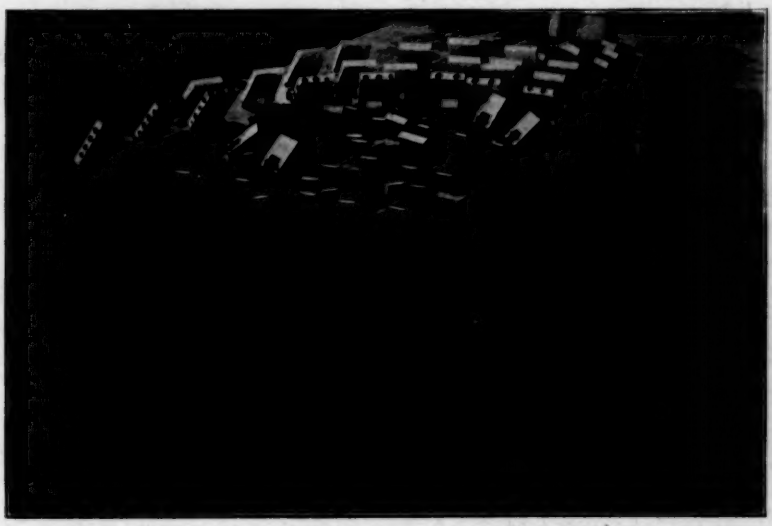


FIG. 2. A LABORATORY TABLE ARRANGED TO REPRESENT THE GEOLOGICAL ELEMENTS OF A RECTANGULAR AREA, EIGHT MILES BY FOUR, WITHIN THE EARTH'S CRUST.

glomerate—has been raised into a dome about the oldest series, as have, for example, the Mesozoic formations of the Harz Mountains of North Germany about the Paleozoic rocks of the core which they envelop.

A third series of sediments is here represented by a flat sandstone monocline in angular unconformity with the limestone upon which it rests. In addition to the granite batholite we have two other igneous rocks appearing in dikes—a porphyry[6] and a basalt.

Preparation of the field map. Supplied with a simple compass and clinometer, each of a number of students is assigned to a table arranged as described in the last section. Each student is also provided with two geologic map bases[7] of

[6]It is not only advisable but altogether necessary to adopt for these problems a few simple rock types designated by names which are comprehensive rather than petrographically descriptive. By porphyry is here meant a siliceous rock of porphyritic texture which may occur either in dikes or flows. Similarly basalt here refers to a non-siliceous and heavy, dark, fine-grained rock which likewise occurs either in dikes or flows.

[7]These base maps are printed in pale green ink on a good quality of paper and can be obtained by the hundred or thousand, as desired, from George Wahr, Bookseller, Ann Arbor, Mich.

the form shown in Fig. 3. His first task is to make his observations and prepare his *field map*, or *map of observed data*. For this purpose he "locates" in its place on the proper section of his base map the position of each outcrop represented in the district, noting the character of each. Of all sedimentary rocks

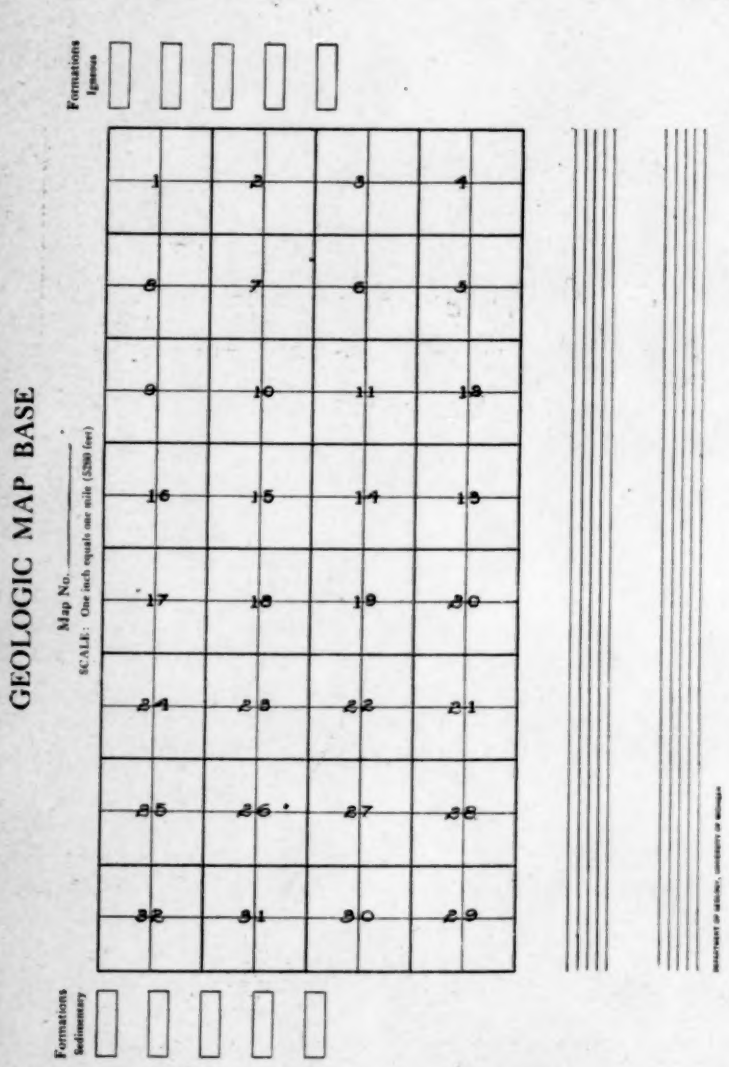
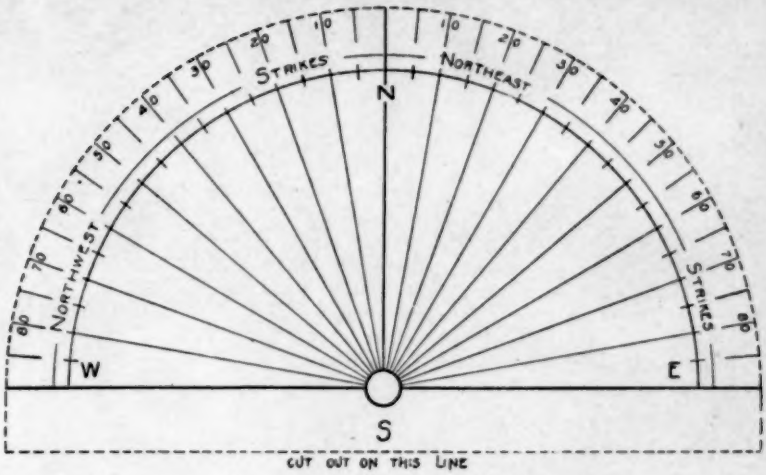
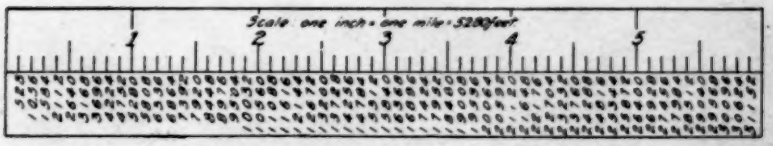


FIG. 3. GEOLOGIC MAP BASE FOR USE WITH LABORATORY TABLES.

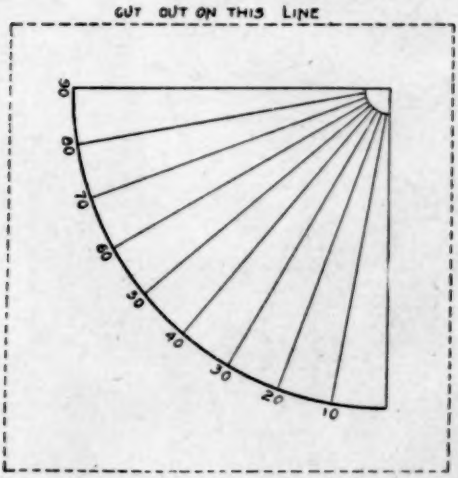
the dip and strike are measured with the clinometer and compass, and then plotted by use of a simple paper protractor (See Fig. 4). The T symbols of Dana in slightly modified form are used to



STRIKE PROTRACTOR



THICKNESS SCALE



CLINOMETER

Natural Sines	
0°	.00
5	.09
10	.17
15	.26
20	.34
25	.42
30	.50
35	.57
40	.64
45	.71
50	.77
55	.82
60	.87
65	.91
70	.94
75	.97
80	.98
85	1.00
90	1.00

FIG. 4. STRIKE PROTRACTOR, THICKNESS SCALE, CLINOMETER DIAL, AND TABLE OF SINES FOR USE WITH STUDY OF LABORATORY TABLES.[8]

[8]These designs, printed in black on one sheet of transparent paper can be obtained in any numbers from George Wahr, Bookseller, Ann Arbor, Mich.

record on the field map the dip and strike observations, the solid head of the T being filled with a color adopted to represent each rock type. Colored crayons are best used for this purpose as they so generally are by working geologists. The flatter

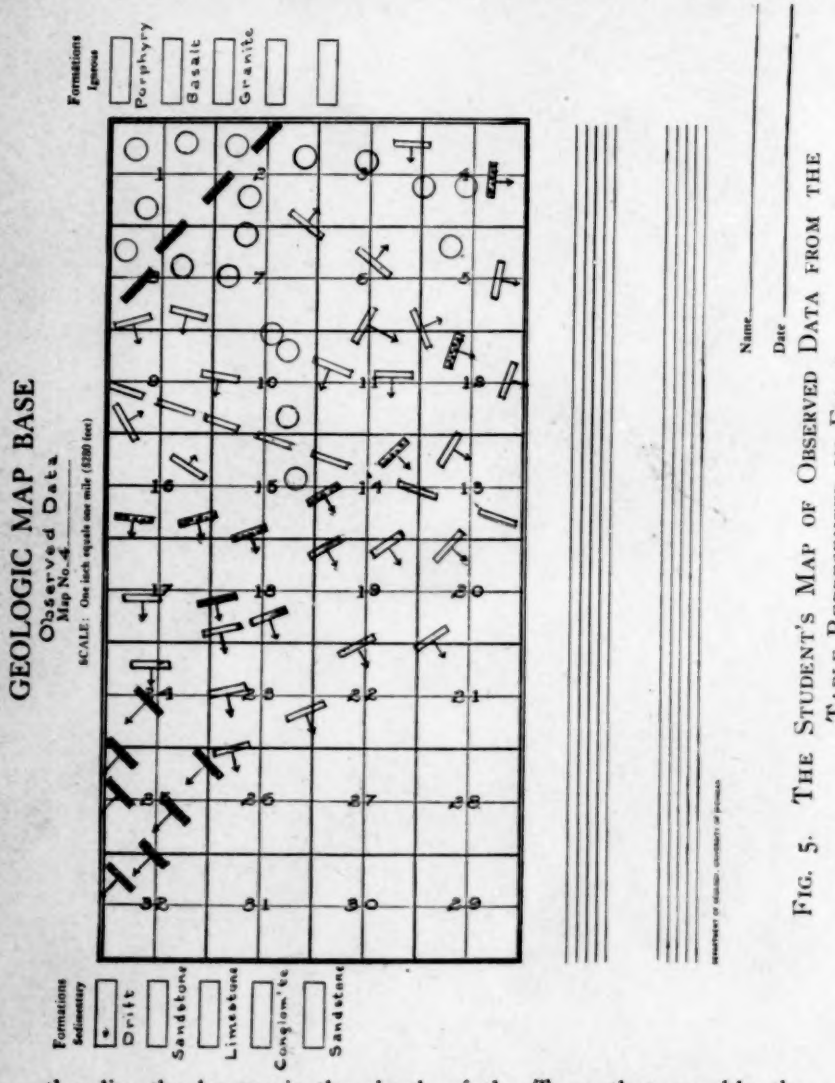


FIG. 5. THE STUDENT'S MAP OF OBSERVED DATA FROM THE TABLE REPRESENTED IN FIG. 2.

the dip, the longer is the shank of the T, so that roughly the length of the shank indicates the length of the projection of the outcrop block upon the horizontal plane. Numbers at the end of the shank may be used to give the measure of the dip.

Outcrops of igneous rocks are represented upon the field map as colored circles unless they appear in dikes, in which case they are entered with the symbol of the sedimentary rocks, but without its barbed shank. The student's map of observed data corresponding to the table shown in Fig. 2 is reproduced in Fig. 5.

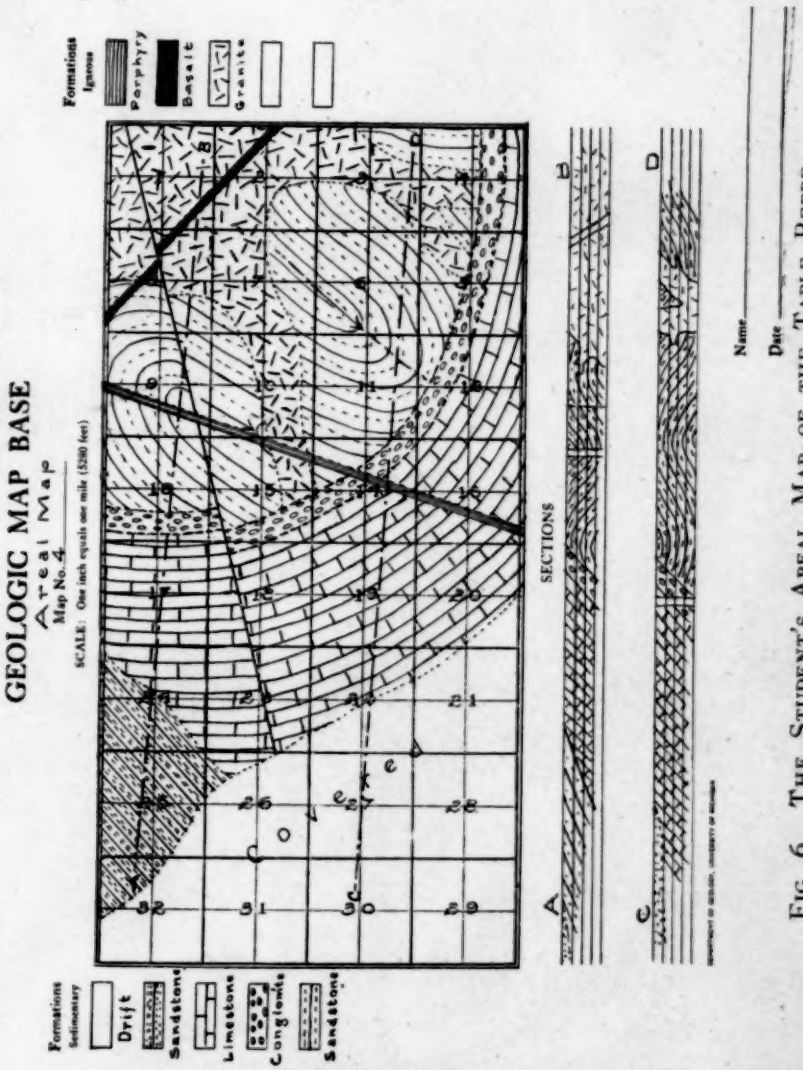


FIG. 6. THE STUDENT'S AREAL MAP OF THE TABLE REPRESENTED IN FIG. 2.

The areal map. The final map (See Fig. 6) is the areal map, which embodies the worker's views respecting the relations

of the several formations to each other, and the areal distribution of each. In preparing it on the basis of his field map the student may perhaps grasp the idea that however complete the final map may appear to be, it none the less embodies matters of considerable uncertainty, which have been settled according to the best judgment of the worker on the basis of the facts at hand. This is regarded as one of the most valuable features of the laboratory exercise, for the aim has been throughout to put the student in the same position as the field worker, merely simplifying the problems through the elimination of unessential details. After the boundaries between formations have been drawn in upon the map, it is colored with crayon, and the student is in a position to derive the main conclusions from his study. In this he is guided by the following general queries and instructions.

General Queries and Instructions.

Stratigraphical.

1. Of the formations represented what ones are sedimentary? What ones are igneous?
2. Which formations, if any, are separated by unconformities?
3. Are any of these angular unconformities? Are any erosional unconformities?
4. What is the order of age of the sedimentary formations?
5. What are the exposed thicknesses of each of these formations? Do any of these values represent full thickness?
6. What is the age in terms of the sedimentary formations of each of the igneous bodies?
7. Which igneous rocks, if any, occur in batholites? Which, if any, in dikes? Which, if any, in flows?

Structural.

8. What formations, if any, have monoclinal dip?
9. Indicate upon the map by dashed lines the crest-lines of all anticlines.
10. In like manner locate by dotted lines the trough-lines of synclines.
11. Indicate by arrows the direction of pitch of anticlines and synclines wherever disclosed by dip and strike.
12. Indicate the approximate position of all normal faults. State which limb is in each case the one downthrown.

13. If dikes are displaced on faults give their indicated direction of dip.

14. Prepare geological sections along the lines indicated.

The better to facilitate the measurement of formation thickness on the basis of the width of exposure, a simple scale on transparent paper has been prepared, and appears upon the same sheet with the strike protractor. An abbreviated table of natural sines adapted for the purpose is also supplied. The general instructions here outlined apply to any of the problems given, but other and special queries apply to each individually. The example which has been furnished by the laboratory table in Fig. 2 is regarded as too difficult for the first exercise, but has here been introduced with a view of indicating the possibilities of the method.

THE ESSENTIALS OF BIOLOGY IN THE HIGH SCHOOL.

By Jean Dawson,

Department of Biology, Normal School, Cleveland, O.

The biology, or rather the botany and zoölogy of our high schools has been from the first undifferentiated from the work of the college. New methods or phases of biology appearing in college soon crop out in the high school, either through a teacher introducing his own college course, with but few changes, or through new and revised text-books. The appointments of the high school laboratory are also modeled after and even rival those of the college, compound microscopes with oil immersion lenses, microtomes and clinostats, are not uncommon pieces of apparatus.

The high school text-books contain the most modern biological thought and theory that is advanced in our universities. Evolution of structure and of sex are treated at some length together with the laws of inheritance, including Lamark's Theory of Acquired Characters and the Mendelian Laws. They are so complete that they form compendiums from which I have seen graduate students studying preparatory to taking an examination for the degree of Doctor of Philosophy. The books announced that they had been prepared for high school texts.

The ungraded condition of biological instruction compels the student of 13 or 14 years to struggle with practically the same

subject matter that he will meet when 18 or 20 years old, if he continues the study in college and university. Indeed, I have visited a university, a college, a normal school, and a high school the same day and found all four studying the *Amœba* in much the same way, thus making it possible to compel the same student to study this animal three or four different times during the course of his education. The men who have written for the high school have given much more thought to the new in the biological world, than to grading material to fit the needs and age of the student of the secondary school. One prominent scientist declares that the high school text is written for the purpose of surprising the author's friend with the depth of his knowledge of biology. However this may be, no subject taught in the secondary schools is so completely unstratified in subject matter and method. This chaotic condition of affairs causes the general unrest and dissatisfaction which are felt and freely expressed at educational meetings, and are reëchoed by our journals of science.

As proof that a reaction has set in against the present biological teaching is the fact that the biology of our high schools is not holding its own with her sister sciences, physics and chemistry. If the biology classes in the high school are not compulsory, they are dwindling and are composed largely of girls.

Biology is usually given in the freshman year of high school and the following results are typical. The schools visited were in one of the larger eastern cities; the time the early part of October. In one high school the students were studying *starch* with the aid of the compound microscope. The instructor informed me that the field excursions were impossible, since the parks were so far from his school, and many of the students could spare neither money nor time, as they had to help bear their school expenses. He said his pupils knew nothing of life outside the laboratory; he ventured to say that not more than three of them could bring a maple leaf if he sent for one. Another school whose teacher enjoyed the reputation of being the best instructor in the city because of her success in preparing students to pass the college entrance examinations, had both a freshman and a sophomore course in biology. She used the modern text-books in her classes and occasionally took her students on an excursion. The freshman class, little girls with their hair braided down their backs, came into the laboratory

and began to study from their text-book. In a short time they were given cross sections of the corn stalk to study with the microscope. The object of the work was to reconstruct mentally a fibro vascular bundle by means of cross and longitudinal sections and then to make a comparative study of the endogenous and exogenous stems. By means of questions the instructor endeavored to draw from her pupils what they could see under the microscope, but met with no better success than is indicated by such answers as "they saw what seemed to be many rings," a "monkey's face" and a "pansyface." I was convinced that these children did not get the faintest idea of the lesson and I recalled what Dr. Mark of Harvard College had said, "Comparative Anatomy is for mature judgments only."

The sophomore class reviewed the study of the *Amœba* and then proceeded to study *Algæ*. As they recited I could but wonder what meaning "Endosarc," "Ectosarc," "Oögonia," "Antheridia" and "Oöspore" really conveyed to them. Think of the task of teaching evolution of structure, germ layers and evolution of sex to children of their age; certainly no one would thus attempt to teach higher mathematics and advanced physics.

How much the students of biology really carry away with them is difficult to say offhand, because of the well-known fact that one may learn to recite glibly on subjects that he knows but little about. Certainly the present course of instruction affords him but little that he can apply to his everyday life.

What college men think of the high school biology is well indicated by the fact that students with no high school preparation enter the college classes on the same footing with those who have spent a year in high school going over much the same ground. Thus far I have never heard a college instructor say that he preferred students with a high school preparation, but I have heard them express opinions to the contrary. Prof. Mark emphatically stated that if it were in his power, he would sweep all of the present biological teaching from the secondary schools. He declares that the students really know next to nothing about the subject, and that they do not do as well as the students to whom the material is new, since the keen edge of interest is worn off.

Although college men condemn the present biological teaching in high school, they themselves are mainly responsible for the present condition of affairs. For what but the present course

of biology could prepare a student to pass an examination on the following questions, which were taken from examination lists for college entrance?

1. Describe the internal structure of a typical leaf, stem and root, illustrating your answer by drawing a cross-section of each.

2. Explain the use of water in higher plants, also how much water is taken in, also how it is given off. Describe experiments illustrating the two latter subjects.

3. How do you know that the protoplasm of the plant and animal cell is identical?

4. Which feet of the larva of a butterfly correspond to those of the imago?

5. What influence has light on the movements of *Lithobius?*

6. Describe any two allies of *Daphinia.*

7. What effect has common salt on *Paramecium?*

8. Compare the external structure of *Nereis* with that of the earthworm.

Should the present biological teaching be done away with in the high school, what could be substituted in its place? Surely not a course that aims to prepare the favored few to enter college, but one that furnishes a knowledge that everyone must have concerning the living things about them in order that they may live more efficiently. It is in the high school that the results of vital scientific investigations now wholly neglected, should be taught, so that the schools may furnish men and women more capable of coping with their environment and acting intelligently in conserving the biological resources of individual, community, state and nation.

To be specific, the student should study the injurious insects, their habits, work, relation to the dissemination of diseases of man and animal, and methods of exterminating them; also the beneficial species and means of propagating and protecting them. The study of birds, their habits, enemies, and the work they do in destroying injurious insects and weeds, should be clearly presented. The student should learn the common food and game fishes of his locality, together with their food and spawning habits, that he may better understand the problems of preservation and propagation that the state and nation are trying to solve. The native trees of the locality should be taught, together with the conditions under which they thrive best, so the

student may appreciate the work of reforesting, together with its effect on drought and floods.

No student should be ignorant of the conditions under which bacteria grow, multiply and are disseminated, in order that he may intelligently guard against dissemination of tuberculosis, diphtheria, typhoid fever and other contagious diseases.

A course covering such practical work should be an essential part of every student's training in the high school. I also believe that the biology that best prepares for life, is at the same time the best preparation for college entrance. And I have been assured by many college men that when the high school course in biology takes on the characteristics above outlined, that there will be little difficulty about changing the entrance examinations. However, the much needed change in the character of the high school biology might be brought about much more speedily if the college would signify its approval by modeling its entrance examination questions so as to demand such changes of the high school.

That the time is ripe for a practical course in biology is indicated by the substitution of agriculture for the present biological course, in many of the high schools. I believe that in the near future a course in biology in the secondary schools that does not furnish a practical knowledge of the child's environment, that he can lay hold of and use, will be impossible. Neither do I think the cultural side of biology will be neglected by the substitution of the practical, for I fail to see why a study of the San José scale, mosquito and the cabbage butterfly, does not give just as much culture as the study of any other insects that have no economic significance.

Who is to give this vital biology in high schools? The present corps of teachers is not trained to deal with the practical, local problems. Dr. Hodge of Clark University, in a recent article says, "We must look to the Agricultural College for teachers for our high schools." At the present time the agricultural colleges are about the only institutions where any phases of practical work is being taught. The day is not distant, however, when every college and university must add a practical course in biology for their students if they would continue to train teachers for the secondary schools.

THE PURPOSE AND ORGANIZATION OF THE TEACHING OF CHEMISTRY IN THE SECONDARY SCHOOLS.

(Symposium continued from June issue.)

HIGH SCHOOL CHEMISTRY.

VI. By Fredus N. Peters,
Central High School, Kansas City, Mo.

Every high school teacher of chemistry is confronted with classes made up of two sets of pupils, those who are fitting for college and those whose school days will soon be over. In the large cities the proportion who expect to continue work at college is high; for example, in our own school, of the 173 members of the class graduating in June, 1909, over 50% signified their intention of going to college. But of these comparatively few will make chemistry a specialty and not a large number will pursue the science further. The question, therefore, seems to narrow down to this, "What should the course in chemistry be which will be most suitable for students who will study this subject no longer?" To this question the answer would most naturally seem to be, "A course largely practical, applying constantly to everyday life, enriching and embellishing high school experiences and those of their entire after life."

This is eminently possible in high school chemistry. No science lends itself better to such treatment. Dirigible balloons, combustion, bleaching processes, refrigeration, explosions, glass etching, petroleum and its refined products, natural and artificial illuminating gases, glass and its varieties, matches, photography, water purification, porcelain wares, soap, soda, baking powders, cements, plaster, hard waters, fireworks, alloys, precious stones, are but examples of the work which may be done. It touches the student at every turn and can be made of the utmost interest.

It does not seem to me, however, that chemistry should be merely this. My experience is that the better students will very quickly grow "stale" as the athlete would say on such a mental spread. They want to know the reason for things, the real chemistry behind all this. Therefore the desirable becomes the necessary. Clear, scientific explanation is needed; solid, substantial chemical knowledge must follow the practical "entree" in order to give the student that mental satisfaction he craves.

The teacher might possibly stop here, but if wise he will not. Thus far we have had the salads, the entrees, and some of the

substantial; a little dessert is not undesirable. For a large number of students some of the theoretical gives a completeness to the science that nothing else can. Ionization, reversible equations, mass action, hydrolysis, the laws of gas volumes, Avogadro's hypothesis, the periodic table, and some others, at least a considerable portion of them, during the latter part of the term are needed every day to explain some of the phenomena presented for study. They must therefore receive considerable attention.

I believe, moreover, if we give a course which will be of the greatest interest to the majority of students who will no longer study chemistry we shall also best meet the needs of the college student who intends to pursue this science in the university. The larger city schools with ten months' term, giving four hours per week to the laboratory and three in the lecture room should be able to send out students the best of whom, with some little supplemental work which might be required of them, would be able to take up qualitative analysis in any university.

Chemistry is unquestionably a thought study. If presented properly it yields to none other, not even geometry or any other branch of mathematics. True, as in any subject, some memory is necessary: some details must be committed, some drudgery must be done, but I firmly believe there is no other science which admits of the possibility of reasoning out so many of its truths in accordance with the laws of common sense. The great "bugbear" with the beginner is the remembering of the ways of preparing the various substances with which he comes in contact in his work. For some months this must be largely memory and need not be stressed too heavily, but toward the latter part of the year, if the subject has been properly presented, he can begin to see the natural and the probable method of proceeding. Common sense dictates the purchase of oak lumber to make an oak cabinet; so, likewise, to prepare ammonia, some compound of ammonia is necessary; for hydrochloric acid, some chloride, etc. The student has learned that, as a rule, chemical combination takes place between electro-positive and electro-negative substances; between acids and bases: so for the expulsion of ammonia from any compound of it a substance of like character—another alkali less volatile than itself. Likewise, for acids. I mention this to illustrate my meaning. In the same way reversible equations become a very simple matter: and set rules which

some books give as to the tendency of one or another class of compounds to form, by this method of thought training give way to the merest common sense. It requires the best part of the year to secure such results; it demands endless repetition; it presupposes a world of patience and forbearance, but the harvest is worth the while. If the chemistry teacher has not learned patience he has missed the first principle of the science. If at the end of the ten months your students have learned to do some logical thinking, they have not only accomplished something in chemistry, but that which will help them abundantly elsewhere.

I fear many high schools attempt too much. Thoroughness should be the aim at all times. What we do at all should be done well. When I began teaching chemistry, I could complete the ordinary high school text, omitting nothing, and have some weeks left from a nine months' term to begin qualitative analysis. Now with a month added to the school year and two hours additional per week to the laboratory time, omitting those elements which various entrance examination committees and others have designated as less important, I can only with the utmost difficulty come in on schedule time. I judge from what I hear, and from what I see in text-books that other schools can do what we are endeavoring to accomplish and then have time for considerable qualitative analysis and some rudiments of organic chemistry. I believe, however, it is a mistake to attempt so much.

In summing up, then, I would say that our high school chemistry course should be rich in the practical applications of the science, with enough of the theoretical and mathematical to give zest even to the stronger students and with sufficient of the quantitative, ten to fifteen experiments, to insure accuracy of manipulation, and thus incidentally meet the demands of our universities; that it should be made eminently a thought and not a memory study; finally, that it should be intensive rather than extensive—a good strong nourishing diet and not soup of the Mrs. Wiggs-of-the-Cabbage-Patch variety. Such a course, I believe, will not only furnish students of whom we shall not be ashamed but also those whom all our universities will be glad to receive.

VII. By Lyman C. Newell,

Boston University, Boston, Mass.

A rather extensive acquaintance with teachers of chemistry through intercourse and correspondence indicates that there is a diversity of views regarding the purpose and organization of the teaching of chemistry in the secondary schools. In some sections, it is true, local conditions or college entrance requirements necessitate uniformity, but taking the country as a whole teachers of chemistry differ widely in their conception of the goal and its attainment. Uniformity may be undesirable and perhaps impossible, because pedagogical ability and material equipment vary. Nevertheless, in elementary fields of instruction the best results are secured by close adherence to the fundamental principles of pedagogy, however much one may be allured aside by personal tastes or ephemeral doctrines. Good teaching, especially of subjects involving laboratory work, is not a matter of scientific etiquette but rather a wholesome and tactful application day by day of the principles that are not only approved by what we may term good scientific society but also tacitly accepted as the evidence of good pedagogical breeding.

It is frankly and joyfully admitted that most teachers of chemistry have an aim. Indeed, science teachers in general give much thought to their work. The pathway in science is not so clearly defined as in ancient languages, history and mathematics. A conscientious teacher of chemistry must be alert, wide-eyed, and progressive; personal, too, if the day's work is to be comfortable for teacher and profitable for pupil.

What should be the aim of the teacher of chemistry? The allusion above to the diversity of aim would seem to imply that no answer could be given to this question, that teachers have solved their local problems, that the proposition is not debatable. The question might be phrased differently. If an experienced, unbiased, cosmopolitan teacher were asked by an unprejudiced neophyte for some principle which could be profitably followed anywhere, what could be a safe answer? Surely something like this: Arouse a scientific spirit by teaching a properly proportioned set of facts and theories judiciously selected from a textbook in chemistry which is within the grasp of high school pupils. This aim is apparently twofold, viz., to instruct and to stimulate. It is really a unit, for a scientific spirit can be

aroused only by proper instruction, while instruction is incomplete unless a scientific spirit is stimulated. The two go hand in hand. They are the two wings by which the bird of knowledge flies.

Assuming that a teacher of chemistry ardently desires to instruct and inspire, how can this aim be accomplished? Here again the answer is apparently twofold, though it is unitary in most cases. We answer, by attaining personal proficiency and by organizing the department of chemistry. The two tasks are interwoven. No instruction can be really profitable unless the teacher is adequately prepared, and at the same time an efficient way to become prepared is to organize one's work. It is a fact, however depressing and undesirable, that too many attempt to teach chemistry without the essential training. Languages, mathematics, and history are usually studied several years before one attempts to teach them, but the science teacher is often sent forth with a meager equipment. The situation, however, is not hopeless. If this article meets the eye of a teacher who realizes his plight, let him not be discouraged. Knowledge of an error is the first step toward its correction. Get to work at once. Set apart one or more evenings for reviewing your general chemistry. Read a recent text-book with a single purpose, viz., to accumulate teaching material for your class; read also some book on the history of chemistry, preferably a brief one, such as Armitage's or Ladenburg's or if convenient a longer one, such as Muir's History of Chemical Laws and Theories or Freund's Study of Chemical Composition.[1] Second, visit other teachers, either at their schools or during a vacation; attend meetings of scientific associations, not merely to hear papers but to meet teachers and get courage to push along. Third, find the weak spots in your teaching and strengthen them; it may take some time to overcome certain defects, but do not lag.

Personal proficiency alone, however, does not guarantee profitable teaching. The department must be properly organized. Some broadly educated teachers prefer to follow their tastes rather than help their pupils; they value research more highly than fulfillment of a contract. As teachers, our first work should be effective teaching, and then, if time and strength permit, we should contribute to the advancement of chemistry by investi-

[1]Miss Freund's book is the most illuminating book that has been written for years. It is an admirable summary of the very topics that most teachers stumble over, and has the added value of accuracy.

gation and publication. It should never be forgotten that the business of a teacher is to teach his classes, and I might add that by this and this alone should a teacher be judged and promoted.

The organization of a department of chemistry is a serious task. Many obstacles interfere, and often the teacher of chemistry is powerless to change certain conditions, for example, congested quarters, conflicts in the school program, electives, requirements of higher institutions, penurious committees, excessive hours of instruction. Nevertheless, in many schools better internal organization is always possible. Sometimes opportunities for complete reorganization come suddenly. Delayed appropriations, a new building, readjustment of the teaching or supervisory corps, or revision of the program may open the doors to the waiting reformer. Hence teachers should be prepared to utilize their privileges.

What is a well organized department of chemistry? An adequate answer to this question would fill more space than SCHOOL SCIENCE AND MATHEMATICS can spare. Therefore, I can only suggest an outline of the answer. The chief feature of a well organized department of chemistry, it seems to me, is economic flexibility. That is to say, the various factors of the class room and the laboratory must be so arranged and related that profitable work can be prosecuted and modified without unnecessary loss to teacher and pupil. Such an adjustable arrangement demands time, foresight, devotion, and judgment. The teacher must actually live in both present and future, just as a manufacturer of fabrics sells one style of goods to-day while he is making another style for to-morrow. A class may suddenly need more lecture table demonstrations, or laboratory work, or recitations, or problems, or review, or a summary by the teacher. If the department is rigidly arranged—"systematized," as some think it should be, whether or no—then the teacher loses time and strength in a fruitless attempt to pump or pummel the pupil into mental activity, while the pupil wonders (if he thinks at all) why he does not "see anything in chemistry." Rigidity means friction, perhaps failure. Flexibility means comfortable work for the teacher and profitable work for the pupil.

A well organized department of chemistry has, of course, several features besides economic flexibility, which might be termed minor features, though at times they may assume major importance. The text-book, for example, is a necessary ad-

junct. Most high school pupils are at that stage of mental development when their progress is a function of the printed page. Moreover, the text-book should be one which the pupil can understand, although the teacher may prefer one which belongs to colleges. A curious notion regarding text-books seems to prevail, viz., that a teacher is more highly regarded the more difficult the book he uses. This is a ludicrous as well as pathetic situation. Teaching is difficult enough under the most favorable circumstances without making it still harder by using an unsuitable book. Furthermore, a teacher, if he seeks a reward beyond the satisfaction of his own soul, ought to look for it from his well taught pupils and not from his contemporaries who do not share his responsibilities and often have only an ephemeral interest in his career. A second feature is the class room work. Formal lectures are falling into disrepute, and deservedly so. Informal talks illustrated by a few simple experiments are more easily assimilated than lectures, though occasional lectures may be used to summarize past work or to prepare the way for theoretical topics. Recitations are essential, because they quicken the laggards and aid all pupils in memorizing helpful facts and laws. Numerous problems—varied from year to year—serve to emphasize the quantitative aspects of chemistry and in some subtle way fix relations in minds which are prone to accept topics as they come along. Correlation is also brought out by frequent reviews, especially after considerable material has accumulated from the laboratory experiments. A third feature is personally supervised laboratory work, so arranged as to time and extent that its performance is determined by pedagogy and not by a program. A successful teacher, well known to the writer, actually moves his classes from the laboratory to the class room and *vice versa*, as occasion demands. A preferable arrangement is to have a class room-laboratory, that is, a laboratory capacious enough to seat a class at one end. This plan is being incorporated into some recently constructed buildings and is thoroughly commendable. Supervised laboratory work yields educational results. Some teachers regard it as too expensive in money, too wasteful in time, or too intangible in training. No doubt laboratory work, even in the teacher's presence, may become all of these, especially if organization does not extend to details. I am thoroughly convinced that personal supervision is the price of success. My views on the psychological aspects of laboratory work

have already been set forth in SCHOOL SCIENCE AND MATHEMATICS[2], and teachers who desire to secure the maximum good in laboratory work are referred to those pages. In the laboratory the pupil asks and answers questions, receives suggestions, literally becomes himself. Here, too, the teacher detects flaws in his teaching, traces errors, and discovers ways and means for a broader and more flexible organization of the whole department.

Not much has been said thus far about inspiration. Indeed, nothing new can be said. Inspiring teachers are, and always have been, those who love their work and their workers, who place service above a fair emolument, and who crave development of the soul above aught else. To such teachers the purpose and organization of chemistry is an achievement that evolves slowly, in fact, the evolution proceeds only as life itself becomes purer, more gracious, generous, honest, and spiritual.

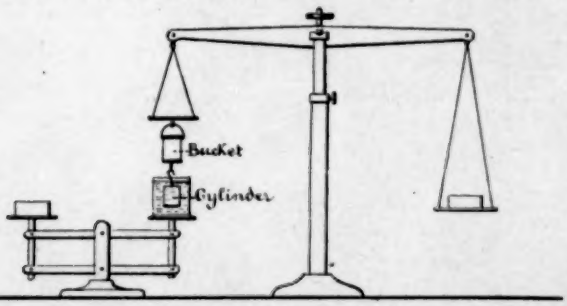
[2]In SCHOOL SCIENCE AND MATHEMATICS, March, 1903, and March, 1907. A reprint of the latter article will be sent on request.

CONVERSE OF THE PRINCIPLE OF ARCHIMEDES.

BY F. C. VAN DYCK,

Rutgers College.

The type of balance with bucket and plug employed for illustrating the principle of Archimedes may be used, in conjunction



with a platform balance, for simultaneous illustration of the converse of that principle.

Referring to the figure, let the beams of both balances be made horizontal by counterpoises before the plug is immersed, the bucket being empty.

Then lower the plug into the vessel of water, step by step,

balancing up each time by transferring water from the jar to the bucket. This process is perhaps familiar.

The following simple experiments are founded upon the converse of the principle of Archimedes.

No. 1.

Upon one pan of an ordinary platform balance place a vessel containing water enough to submerge a body, the specific gravity of which is to be determined. Upon the other pan put any convenient counterpoise to make balance arms horizontal. A body denser than water, say a piece of iron, is suspended by a string and lowered into the water until just submerged. Then put weights on the counterpoise to make the beams horizontal, and note the sum of these weights as W. W is the weight of the water displaced by the iron. Next lower the iron until it rests on the bottom of the vessel containing the water, slacken the string, add weights to the other side until the beams are horizontal, and put the total of the weights as W′. W′ is the weight of the iron "in air" (for the iron might lie on the pan outside of the vessel of water without altering W′). Hence the sp. gr. of the iron is W′/W.

No. 2.

As in No. 1 except that a body less dense than water is used; say a block of paraffined wood. Float it on the water and make the beams horizontal with weights summing up to W. W is, of course, the "weight in air" of the block. Stick a needle into the top of the block, and push it down under the water, adding weights to those already on the other pan until beams are horizontal, noting the total of the weights as W′. W′ is the weight of a volume of water equal to the volume of the block. Hence W/W′ is the sp. gr. of the block.

No. 3.

Balance, vessel of water, and counterbalance, as in Nos. 1 and 2. Suspend a large glass stopper, or other body denser than water, by a string and submerge it in the water. Make the beams horizontal with weights summing up to W, which is the weight of a volume of water equal to the volume of the stopper. Then substitute for the vessel of water a vessel of another liquid, say kerosene, and counterbalance it. Submerge the stopper in the kerosene and make beams horizontal with weights amounting to W′. W′ is the weight of a volume of kerosene equal to the volume of the stopper. Hence the sp. gr. of kerosene is W′/W.

IONIZATION THEORY. DEMONSTRATION WITH APPLICATION TO ELECTROLYSIS.

By Harry A. Carpenter,
West High School, Rochester, N. Y.

It has been known for a long time that the freezing point of a solvent is materially lowered by the solution of some substances and the boiling point of the liquid is raised; but until the study of osmotic pressure and its cause was taken up, the exact quantitative effect of solutes on the points in question was not much considered. Then it was found out that the amount of lowering of the freezing point or raising of the boiling point was proportional to the amount of *solutes* used, and with some organic acids, salts, etc., the effect was determined to be proportional to the number of dissolved molecules. According to Raoult, one molecule of solute to 100 molecules of solvent produces a lowering of the freezing point .63° largely independent of the nature of the solute, and the raising of the boiling point of liquids is proportional to the number of molecules of solute. Also, the osmotic pressure of a solution is proportional to the number of parts of the solute.

This relation seemed to hold good until applied to solutions of some of the minerals, acids and salts. These solutions have a greater osmotic pressure, a greater lowering of the freezing point and a greater increase of the boiling point than the dissolved number of molecules would indicate, and, in fact, in dilute solutions the amount of change is double the effect produced by the organic materials. With either class of solutes, solutions having the same osmotic pressure have the same freezing points.

Solutions of nearly all substances have some power of conducting the electric current and the conducting power was found to bear a definite relation to the number of dissolved molecules of the organic compounds. As in the case of osmotic pressure so with the conductivity. Dilute solutions of minerals, acids, bases and salts gave double the conductivity deduced from the number of dissolved molecules. All these facts indicate that the effects produced are in proportion to the number of dissolved parts of the solute, whether molecules or parts of molecules; and, inasmuch as in dilute solutions of some compounds the effect is double the effect required by the number of whole molecules, it seems reasonable to assume that each of these molecules under the condition is broken into two parts.

It is interesting to know that investigators have established the fact that the osmotic pressure, lowering of the freezing point and increase of the boiling point of a solution is proportional to the number of dissolved parts of the solute and that the effect is in most cases independent of the nature of the "part" whether it is a whole molecule or a part of a molecule.

Having considered briefly the historical development of some of the facts of solution, how shall we state and develop the theory in order that a high school class in chemistry may get the most for themselves? In order to avoid confusion I think it a good plan to state the theory in two parts, and to demonstrate, as far as possible, each part separately.

First.—When some substances are dissolved their molecules are more or less separated into two parts called ions, which are to some extent freely moving bodies in the solvent.

Second.—These ions carry charges of positive or negative electricity produced, perhaps, as a result of the tearing apart of the molecule by the energy of solution much as the charges are produced on glass and fur, and the conduction of an electric current through a solution is made possible by these ions migrating toward oppositely charged poles or electrodes. Also, solutions of those substances whose molecules do not ionize will not conduct a current.

To prove the first proposition, then, let us consider the following facts. Anhydrous copper sulphate is white. White, therefore, must be the color of the copper sulphate molecule and if mixed with flour it would suffer no structural change and would not change the color of the flour. In the same way it we could mix it with water, that is dissolve it in water, without its structure or unity being changed it ought to produce no color change; but the fact is copper sulphate solution is blue. Has there been a structural change? If we dissolve copper nitrate in water the solution is also blue. Anhydrous copper chlorid is yellow, and mixed with flour gives it a yellow tint, but when dissolved in water makes a blue solution which on being heated turns green. The blue color of copper solutions evidently is not due to the color of the molecule. But since all copper salts give a blue solution, regardless of what the acid radical may be, we are led to the conclusion that the color is due to the one constant part, the copper, and this necessarily presupposes a structural change or separation of the molecule into the metal part and the acid radical part.

If we examine solutions of potassium sulphate, potassium nitrate and potassium chlorid we see that they are colorless; hence, it is certain that if these salts separate the acid radicals do not give color to the solutions, and we must reason that the color of the copper salts in solution is due to the copper part and not to the acid radical part, and as we have seen above, it is not due to the molecule as a whole.

I have said that anhydrous copper chlorid is yellow and its solution in the cold is blue, but if heated turns green. This indicates that in the hot solution some color (yellow) is due to the molecule as a whole and some color (blue) is due to the copper part of the separated or ionized molecules and the resulting color is what we would expect—green. Examination of solutions of nickel salts shows them all to be green, regardless of the acid radical. Solutions of chromium salts are all bluish green.

Water solutions of all cobalt salts are pink. Anhydrous cobalt chlorid is blue, therefore the color of the cobalt chlorid molecule is blue; hence the color of its solution in water is not due to the molecules as units. If a solution of cobalt chlorid could be made so that the salt would not be ionized the color of the solution should be blue. An alcoholic solution of cobalt chlorid is blue and we must conclude that the color is due to the cobalt chlorid molecules as units. Now if our theory is correct the addition of water to this blue solution ought to cause the molecules to split up or ionize and give the pink color due to the cobalt part, and such is the fact. Therefore, we must conclude that the energy of solution causes the molecules of some substances to separate more or less into two parts, which Faraday called ions. It must not be concluded that it is always the metallic ion that is colored, for the potassium ion is colorless. It is true that the chromium ion is bluish green, but combined with oxygen in the acid radical of potassium chromate the color of the solution, yellow, is due to the CrO_4, while in solutions of potassium bi-chromate the color is red due to the Cr_2O_7 ion.

Water has greater power to cause ionization than any other solvent. Methyl alcohol has greater ionization power than ethyl alcohol, in fact ethyl alcohol causes very little ionization. Also, some compounds are more dissociated by solution than others, e. g. in general minerals, acids, bases and salts dissociate more than organic compounds. In either class those substances that

dissociate but little are called weak and those that dissociate readily are called strong.

For our proof that the ions possess charges of electricity it is only necessary to note the actions of solutions of dissociated compounds when subjected to the influence of the electric current. First of all let us consider a solution of sodium sulphate. According to the theory when the salt is dissolved in water it is separated into sodium ions and sulphate ions. Sodium in the ordinary metallic or molecular state reacts violently with water with the liberation of hydrogen and the formation of sodium hydroxide. Why, then, if sodium exists as a free body or ion in solution does it not produce the same violent reaction? Evidently it does not, therefore we must conclude that it is at least different in some characteristics from ordinary sodium. If this difference is the possession of a charge of electricity by the sodium ion, then, if that charge could be neutralized or discharged, the sodium ought to act as ordinary sodium and decompose water. A solution of sodium sulphate is neutral to litmus and is colored violet with litmus. If the solution is placed in a U-tube and platinum electrodes from a battery placed in the solution at the top of each arm, and a current passed, after a time the solution in the arm containing the positive electrode turns red and the solution in the arm containing the negative pole turns blue. Therefore in the positive arm is produced an acid and in the negative arm is produced an hydroxide. This indicates that the sodium ion is charged positively and the sulphate ion negatively; for if considered from the standpoint of the ionization theory the observed results ought to occur. If we assume a positive charge on the sodium ion and that it is free to move, then on introducing into the solution a sufficiently strongly charged negative electrode we would expect that the sodium ion would migrate to that pole. Here one of two things would happen. The sodium ion if it touched the electrode would have its charge neutralized. It would then as atomic sodium react with water and form hydrogen gas and sodium hydroxide. The hydroxide formed would react with the litmus and produce the blue color.

Or, as is more likely, if there were a few molecules of dissociated water, as seems true, then, instead of giving up its charge to the pole, the sodium ion having a higher discharging potential than the hydrogen ion present, takes the place of the hydrogen ion to form dissociated sodium hydroxide while the

hydrogen ion from the water gives up its charge to the pole and escapes in the form of a gas. In either case the sodium ion must have been charged to cause it to migrate to the negative pole. In the same manner the sulphate ion would migrate toward the positive pole, there a free hydroxyl ion having a less discharging potential than the sulphate ion gives up its charge, reacts with water, liberating free oxygen and forming water, and leaves two hydrogen ions, which with the sulphate ion forms dissociated sulphuric acid which turns the litmus red.

Also, if the current of electricity is passed through solutions of salts of the harder metals the metallic ion always migrates to the negative pole. For example, if a solution of lead acetate is used, the lead collects at the negative electrode in the form of a tree and if the current is reversed the lead is gradually taken away from the original pole and deposited on the other pole, now the negative. The electrodes being merely extensions of the poles of the battery or generator are charged positively and negatively and the ions being charged bodies and free to move obey the law of electro-statics. In fact the so-called conduction of a current through a solution is made possible only by virtue of these charged bodies or ions. If, for example, a solution of sugar is used we find it will not allow a passage of the current. Moreover, boiling point, freezing point, and osmotic pressure tests show that sugar mixes with water in the molecular form without separation into parts, hence no free ions exist in a sugar solution, and according to our theory ought not to conduct an electric current.

(To be continued.)

THE ESSENTIAL EQUIPMENT FOR TEACHING ELEMENTARY PHYSICS.*

By Frank F. Almy,

Professor of Physics, Iowa College, Grinnell, Iowa.

When asked to discuss any topic in connection with secondary school teaching my mind reverts to a quip credited to Lord Rosebery. When asked to define memory, he is said to have replied that memory is the sensation which creeps over one when a friend tells an original story.

*Read at the Science Round Table of the Iowa State Teachers' Association, Jan. 1, 1908.

One must needs be a genius who shall discuss any phase of the teaching of elementary physics without stimulating the aforesaid sensation. For, beginning with the report of "The Committee of Ten," in 1893, the various questions involved in the teaching of elementary subjects have been discussed hither and yon until it would seem that there can be no phase of the subject that has not been many times, settled beyond all controversy. And yet we have the "New Movement Among Physics Teachers," which seems to be developing a wide group of teachers inclined to take quite a new attitude toward the teaching of elementary physics.

If there is any phase of the subject which has not been worn threadbare in this discussion, it may be that indicated by the topic which has been suggested for this paper. Under this topic, I shall attempt to discuss essentials as contrasted with non-essential desiderata, and I hope that this point may remain distinctly in mind.

I wish also to direct the attention upon the one year course in Elementary Physics. There have been numerous syllabi of such courses presented, a considerable number in the main good, and differing but slightly among themselves. But a syllabus will not teach a successful course in elementary physics. I am a staunch believer in the Garfield College but the log is not the essential. The syllabus served a most important function in the teaching of physics in the decade following 1893. It compelled the teacher to sit up and take notice, to take account of stock, and to make conscious analysis of the work to be done and to apportion his effort equably to the subject matter to be presented. The debt of elementary physics to those who have followed the lead of Professors Trowbridge and Hall, who gave the original syllabus, that incorporated into the Report of the Committee of Ten, and which forms the body of practically every elementary laboratory manual published in the decade following, has not been overestimated. And while the "New Movement" or a new movement may very materially modify the subject matter both of classroom and laboratory work, there will remain the consciously consecutive and correlated treatment of subject matter with quantitative laboratory work, which is the outgrowth of the Harvard movement through those who have followed it.

But whatever the syllabus, the question of successfully teaching elementary physics is not determined by the omission or failure to omit certain topics from the discussion, by the demonstration or neglect to demonstrate particular phenomena or by the inclusion

or the exclusion of a topic from the laboratory work. The syllabus is a guide, and indicates the treatment to which each topic lends itself, but the competent teacher may safely be, and at times must be, a law unto himself.

But to the topic: "The Essential Equipment for Successfully Teaching Physics."

The prime essential is a teacher; a capable teacher of tact and abundant common sense. I know of no better discussion of this topic than that of Professor Hall in his "Teaching of Physics in the Secondary School." (Longmans 1902.) Professor Hall in opening his discussion says, "As in any other department of pedagogic art, there is in physics the teacher who is born and the teacher who is made. The latter if successful, is the product of infinite labor, of longsuffering patience with himself, of constant courage, of never-dying willingness to learn." The teacher of physics should not be a utilitarian. To quote Superintendent Bardwell,—"When the patrons, the members of a class or a teacher or all three of these feel that the information to be obtained from a course in physics is its chief reason for its place in the schools, that subject will be taught in a weak and insufficient manner.—I wish to urge that the attention be given not so much to the science as to the people who are being instructed in the science." (Sch. Sci. Vol. III, p. 443. The vision of the teacher of physics should be no less restricted, no less humane than that of the teacher of the humanities. His mission to society, to civilization, is constructive. He should be no less creative, not less inspiring to men because of the utility of physics.

In addition to the qualities of inspiring leadership demanded of any teacher, the teacher of physics needs—to again quote Professor Hall, "capacity for clear, sustained, correct thinking,—capacity for quick understanding of mechanisms—a considerable degree of skill and proficiency in the use of tools, a reasonable acquaintance with the processes of the work shop." He should know his subject beyond that he expects to teach in order to have perspective; he must always seek to know more both by study and by investigation if of nothing more than of the small problems that arise out of his own experience and associated with his own work. He must be alive and keep abreast of the trend both of work and methods,—but he "should be a physicist, rather than a pedagogist with an inclination toward physics." He must be long in common sense and in his knowledge of common things,—for I believe, with

Professor Crew,* that the facts of elementary physics are largely already the common knowledge of the pupil, and the teacher must have the capacity to use this fund of common knowledge and of shaping it into an orderly arrangement of facts—"organized common sense"—a science. Do not understand me as for a moment making a plea for phenomenology; the work should be elementary physics. It is entirely possible that a course in phenomena might be used in connection with the nature study work of the last grades of the grammar school and be of much greater educational value than work that is now given there, but the youth of high school maturity, in my humble opinion, needs the more solid form of work.

The teaching of elementary physics can be successful without further equipment, but conditions do not ordinarily obtain which are conducive to make that kind of instruction successful. The second essential is equipment for demonstration. This need not be elaborate to be effective. It must be such as will make a real contribution to the information that the pupil already possesses. It should supplement the demonstrations of physical principles, laws, and phenomena that can be drawn from the every day experience of the pupils by presenting illustrations not familiar to the pupil and which on that account are impressive; and by the repetition of familiar phenomena in order to obtain accurate observation of details that escape in the casual observation. Demonstrations should not be introduced that do not in some way contribute to the education of the pupil. Of necessity, then, the experiments actually performed before the class should vary with locality, as will the supplementary illustrations drawn from the fund of common experience of the pupils. The sensational and spectacular, and particularly the involved demonstration, is to be avoided, in favor of the simple experiment which directly demonstrates the physical principle or phenomena involved. It is entirely possible to revive the much lamented "go" in physics in legitimate ways. As illustrating these points:—I would consider the air pump and accessories valuable because few pupils are familiar with satisfactory illustrations of the phenomena here involved and the field it illustrates is large. The whirling table and accessories are similarly useful, and so also is most of the apparatus that receives general acceptance in demonstration use.

With this equipment, viz., a capable, tactful, resourceful teacher

*Elements of Physics.

with sympathy and vision; with properly selected and even limited demonstration equipment with which to get certain phenomena clearly before the pupils while under discussion, I am not prepared to say that elementary physics cannot be successfully taught. I am, however, very thoroughly convinced that in the vast majority of schools under the conditions that now almost invariably obtain, and certainly in the present stage of the evolution of science teaching, experimental work on the part of the pupil is a very material aid to successful teaching of the subject, I believe that the nature of this personal experimentation should be very materially influenced, just as in the demonstration work by the habits and experience, by the life and ideals of the pupils. The work of the classroom and that of the laboratory must complement the knowledge that the pupil has obtained through previous experience and correlate and co-ordinate the whole. To me it seems self-evident that in the nature of things there should be a radical difference in discussion, in demonstration and in the personal work of the pupil in the country town or small city from that in a factory town and each in turn differing from that in a school in a large city. The competent teacher has his syllabus,—or syllabi,—toward which his course should measure up.

In qualitative experiments the apparatus should be reliable in order to maintain the confidence of the pupil; in order to avoid confusion by the erratic results. In quantitative work there should be no failure of apparatus which shall lead the pupil to the attitude that the results finally obtained are guess work or juggled. The apparatus should permit doing quantitative work otherwise it fails. The apparatus should be assembled in a workmanlike manner; and whether it be commercial apparatus or made by a local mechanic, it should be finished and wear an air of respectability at least equal to its surroundings. It must be apparatus which commands respectful treatment from the pupil throught its appearance and apparent adaptability to its purpose; it must maintain the respect of the pupil by consistent, truthful performance. If it does this, successful laboratory teaching can be accomplished through it, whether it be made by Golaz of Paris, or by Jones, the local smith.

For utility in teaching and economy of effort of both the instructor and the pupil the laboratory work should be consecutive in subject matter, with the discussions and demonstrations. This can generally be accomplished with such duplication of apparatus

as will permit one-third of the class to work upon one experiment at one time. This need displace no experiment more than two laboratory periods from the place in time which it would occupy if sufficient apparatus were provided for the class to work abreast. I have employed both methods and in my own experience do not find the inherent evils of the two methods to differ materially. It is more agreeable and economical of the teacher's effort for the class to work abreast, but it is in no way necessary to successful laboratory work.

I think I have now covered the field indicated by the tropic, and yet I cannot pass without calling attention to two other things that are absolute essentials to every successful teacher of Physics; viz., an emergency fund and a shop. As to the first; there are constantly occuring unforeseen demands for materials and supplies which the teacher must be able to meet at once, without the preliminary of an order through a superior or the board. The shop in some form or other is an essential, no successful teacher of Physics will be without. It may be very simple and its equipment meagre, or ample provision may be made for wood and metal working. For satisfactory work it should contain a work bench and bench tools for working wood and metals, with a lathe and lathe tools; each in sufficient assortment to permit making the necessary repairs and modifications of apparatus demanded by the lecture room and laboratory. Further in the hands of a teacher with capacity for that work sufficient apparatus may be made and remodled or adapted through the means of the shop equipment to make it a financial economy as well as a utility.

To summarize then: The prime essential—the teacher, capable, progressive, tactful, resourceful; the teacher with capacity for clear, correct thinking, for understanding of mechânism and deft in manipulation; with some degree of mechanical knowledge and skill; a teacher with vision, with qualities of leadership, and with appreciation of citizenship.

Second—Equipment in apparatus and accessories, somewhat determined by the environment, to enable the teacher to demonstrate before the classes qualitatively and in part quantitatively such phenomena as will complement the fund of knowledge already possessed by the pupils.

Third—Equipment for personal experimentation, largely quantitative to supplement the conception of, and acquaintance with the subject obtained in the classroom; to enable the pupil to have a

"realizing sense of things by coming into contact with them." This apparatus equipment should be presentable in design and workmanship, reliable in operation, sufficiently simple in construction so that its operation and manipulation is within the comprehension of the pupil. It should be provided in sufficient duplication to permit the laboratory work to be co-ordinated with the class work into an integral whole, and permit the pupil to do individual work wherever possible.

And finally the guiding precept through all should be utility with economy; the application of all to the making of men.

A SUBSTITUTE FOR LAMPBLACK.

By Floyd R. Watson,

University of Illinois.

The use of a substance like lampblack has become a feature of experimental work in physics where a trace of some kind is desired. Lampblack is especially suited to this purpose because it is light and offers little friction to a stylus in making a trace. It has one disadvantage—it is dirty. Teacher and pupils alike are annoyed by the black smudges that appear on clothes and papers where experiments are performed that make use of lampblack.

Because of this disadvantage, a search has been made for a substitute. Blaker[1] found that "Bon Ami" served his purpose and was an improvement over lampblack in a number of ways.

The author has taken advantage of Blaker's suggestion and used "Bon Ami" in experiments where it is desired to record the trace of a tuning fork on glass. It was found, as Blaker pointed out, that the new substance offered more friction to making a trace than did lampblack. To lessen this trouble other substances were tried. A solution of corn starch was found to be more satisfactory. This solution was placed on the glass by means of a brush and allowed to dry while the glass was kept in a horizontal position. Four parts by volume of water to one of starch made a satisfactory solution. The starch sinks to the bottom, making it necessary to stir the mixture well before placing it on the glass.

---

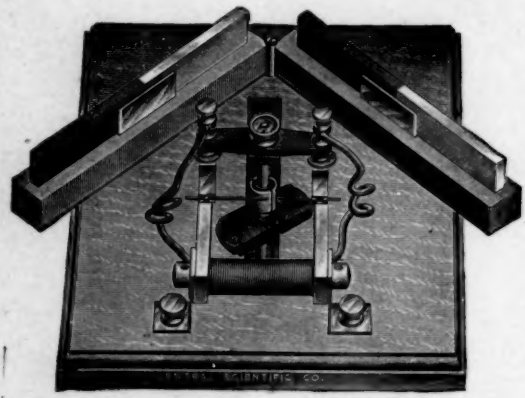
[1]Physical Review. Vol. 16, p. 236.

THE ST. LOUIS LABORATORY MOTOR.

By S. A. Douglass,

Soldon High School, St. Louis.

The St. Louis Laboratory Motor has been designed as an instrument to be put into the hands of secondary pupils. It is the outgrowth of a long series of experiments conducted by the physics teachers of the St. Louis high schools, and embodies many valuable teaching features. It has been designed to show all of the fundamental features of the electric motor, and at the same time has been kept simple in construction, and so open in structure that all of the parts may be easily inspected. If desired, it may be taken apart for closer inspection and study. It will operate on the current furnished by one or two dry cells. The necessary magnetic field is secured either by a pair of permanent bar magnets (Fig. 1), or by an electro magnet (Fig. 3).



With the magnetic field obtained by the use of the bar magnets, the following features may be shown:

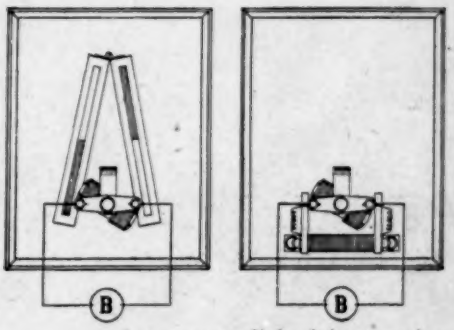
1. The Fact and Cause of Rotation:

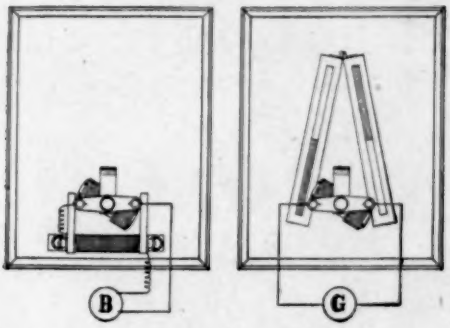
The fact of rotation is self-evident when the machine is once in motion; but the cause of rotation is a more subtle problem. By swinging the two magnetic poles away from the rotating armature (Fig. 1), its motion soon ceases, thus showing that the presence of a magnetic field in the region of the armature is an essential condition of motion. The armature will rotate with but one magnet in place, but with a slower speed. If the bar magnets are arranged so that the armature is between two like poles, the armature again refuses to rotate, thus proving that the lines of force must cross over from one pole to the other, or that the two poles must be of opposite polarity.

If the bar magnets be turned aside, and, with a compass, the polarity of the two ends of the armature be tested throughout one *complete* revolution, it will be found that, within a certain region bounded by a straight line passing through the center of rotation and connecting the two poles, the armature pole is always north seeking, and in the region on the opposite side of the line, the armature pole is always south seeking. By examining the polarity of the bar magnets constituting the field, it may readily be seen that there are two attractive and two repelling forces acting on the poles of the armature, all tending to produce rotation in the same direction.

2. Direction of Rotation.

Starting with all the conditions as in the case above, the direction of rotation may be reversed, first by reversing the current through the armature, and second, by reversing the polarity of the field magnets. The latter is





accomplished by turning the magnets end for end, or interchanging them. In either case, a comparison of the polarity of the magnet poles and the armature core will explain the direction of rotation, in accordance with the principles given above.

If we start again with the original conditions, and reverse both the polarity of the field magnets and the direction of the current in the armature, the direction of rotation will remain unchanged.

3. Rate of Rotation.

By introducing a resistance box, or some other means of current control, into the electric circuit, the armature current may

be diminished. Thus reducing the current will also reduce the rate of rotation.

A second method of varying the rate of rotation is to shift the brushes, so as to alter the point of commutation. This is easily accomplished by rotating the top piece (Fig. 1) to which the brush holders are attached.

It might be of interest to note just here that the brushes of this little motor consist of a straight piece of wire held in place by a spring brass clamp. The brushes may be removed when desirable. They may be moved in and out, so as to secure a light contact with the commutator segments. This is quite essential, otherwise the friction of the brushes will retard the motion of the armature, or prevent motion altogether with weak currents.

In order to represent the exact conditions found in the practical motor, this little machine is supplied with an electro-magnet to furnish the necessary magnetic field. Of course the essential features of its operation are the same now as before, such as the cause of rotation, direction and speed of rotation, etc. By making the proper connections, the machine may be made either a parallel wound (Fig. 3), or a series wound (Fig. 4) motor. An interesting feature that may be brought out here is the fact that if the motor is operated first with the parallel arrangement (Fig. 3) and then be changed to the series arrangement (Fig. 4), leaving the positive wire connected to the same binding post as before, the rotation of the armature will be reversed. This forms a simple little electrical problem for the student to explain.

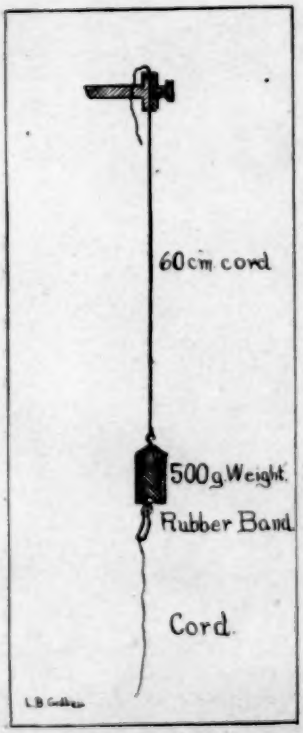
By removing the battery and substituting for it a sensitive galvanometer (Fig. 5), the apparatus may be used to show the characteristics of the dynamo. By swinging the magnets aside, the armature may be given a good vigorous rotation. On moving the magnets into position, the galvanometer will be sharply deflected. If the direction of rotation be reversed, the direction of deflection will also be reversed. By reversing the polarity of the field magnets, but keeping the direction of rotation the same as before, the current through the galvanometer will again be reversed. As the speed of rotation of the armature decreases, the deflection of the galvanometer shows that less and less current is flowing, hence the electro-motive-force generated must be decreasing. This proves that the value of the induced E. M. F. is a function of the speed of rotation.

By swinging the magnets in and out while the armature is rapidly rotating, the strength of the magnetic field may be so altered as to produce a decided change in the strength of the induced current. As the field grows weaker, the galvanometer shows a smaller deflection, and as it is strengthened, the deflection is also increased. This proves that the value of the induced E. M. F. is a function of the strength of the magnetic field.

EFFECT OF VARYING "G" ON THE PERIOD OF VIBRATION OF A PENDULUM.

By Charles H. Slater,

Department of Physics, McKinley High School, St. Louis.



A common method suggested for demonstrating the above is to mount a strong magnet beneath an iron pendulum bob. The field being of unequal strength soon causes the ball to swing very erratically. The accompanying figure shows another way which has proven much more satisfactory. The number of swings for ten seconds is taken with no pull on the lower cord. It is again timed with a moderate pull and a third time with a harder pull. The effect is very marked and the application easily grasped by the pupil.

PROBLEM DEPARTMENT.

E. L. BROWN,

Principal North Side High School, Denver, Colo.

Readers of the magazine are invited to send solutions of the problems in this department and also to propose problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott St., Denver, Colo.

Algebra.

155. *Proposed by I. L. Winckler, Middlebury, Vt.*

A purse contains five dimes, one of which is marked; another contains five unmarked dimes. Four coins are taken from the former and put in the latter; and then four are taken from the latter and put in the former. Find the probability that the marked dime is still in the first purse.

Solution by I. L. Winckler, Middlebury, Vt.

The probability that the marked dime was among the four taken out of the first purse and put into the second is 4/5.

The probability that it was not among the four taken out of the second purse and put into the first is 5/9. $\therefore$ $4/5 \times 5/9 = 4/9$, is the probability that the marked dime is in the second purse, and therefore 1—4/9 or 5/9 is the chance it is in the first purse.

Geometry.

156. *Proposed by John J. Quinn.*

AB is equal and perpendicular to BC; D and E are their mid-points. On AB as a diameter describe a circle. Draw CD to cut the circumference in F and F'. Draw EF' cutting AB in M, and EF produced to meet AB produced in M'. Prove that M'A:M'B=MB:MA.

Solution by Hamlet P. Collins, Rahway, N. J.

Lemma. A line from the mid-point of one side of a triangle through the second side to meet the third side produced, divides the second side internally and the third side externally in the same ratio.

Let ABC be the given triangle, H the mid-point of AB, E a point in AC, and let HE meet BC in D. Through A draw AF parallel to BC and meeting DEC produced in F. Obviously, AF=BD. In the similar triangles AEF and ECD (substituting BD for AF).

BD:CD=AE:EC.

Returning now to the figure of the given problem:

$$\frac{CF'}{DF'} = \frac{BM}{MD} \text{ or } \frac{CF'}{2DF'} = \frac{BM}{2MD}.$$

$$\therefore \frac{CF'}{CF' + 2DF'} = \frac{BM}{BM + 2MD} = \frac{BM}{AM}.$$

If r is the radius of the circle, by right triangles, etc.

$$DF' = r,\ CF' = (\sqrt{5} + 1)r,\ \frac{BM}{AM} = \frac{\sqrt{5} + 1}{\sqrt{5} + 3} = \frac{\sqrt{5} - 1}{2}.$$

Similarly

$$\frac{BM'}{DM'} = \frac{CF}{DF},\ \frac{BM'}{BM' - DM'} = \frac{CF}{CF - DF} \text{ or } \frac{BM'}{BD} = \frac{CF}{CF - DF}.$$

$$\frac{BM'}{2BD} = \frac{CF}{2CF - 2DF}; \quad \frac{BM'}{BM' - 2BD} = \frac{CF}{2DF - CF}.$$

$$\frac{BM'}{AM'} = \frac{CF}{2DF - CF} = \frac{\sqrt{5} - 1}{3 - \sqrt{5}}.$$

$$\frac{AM'}{BM'} = \frac{3 - \sqrt{5}}{\sqrt{5} - 1} = \frac{\sqrt{5} - 1}{2}. \qquad \therefore \frac{BM}{AM} = \frac{AM'}{BM'}.$$

Remark by E. L. Brown.

AB is divided in extreme and mean ratio, internally at M, externally at M'.

157. *Proposed by W. T. Brewer, Quincy, Ill.*

A conical cup 6 inches high and 5 inches in diameter is one fifth full of water; what must be the diameter of a ball dropped into the water that shall just be immersed by it?

Solution by Proposer.

Let ABC be a section of the cone, vertex C, D the mid-point of AB, O the center of the inscribed sphere, G the center of the required sphere, OE and GF perpendiculars on AC; KL tangent to the sphere G and meeting AC in K.

Let ABC be a plane coinciding with the axis of the cone, OE, the radius of the inscribed sphere, and GF, the radius of the required sphere, KL being the top of the water. AD=2½, DC=6, and AC is found to = 6½ in. AE=AD=2½, and CE=6½−2½=4 in. By similar triangles CD:AD=CE:OE, whence OE=1⅔ in. Hence volume of inscribed sphere=19.39 cu. in.

$5^2 \times \frac{1}{4}\pi \times 2 = 39.27$ cu. in., volume of cone.

39.27÷5=7.854 cu. in. of water in cone.

By similar solids 39.27—19.39:19.39=7.854: 7.66+volume of required sphere, and $\sqrt[3]{\left(7.66 \div \frac{1}{6}\pi\right)} = 2.44+$ inches its diameter.

158. Through a given point P, to draw a line perpendicular to a given plane.

Solution by M. H. Pearson, Dothan, Ala.

I. Solution. Case 1. When the point does not lie in the given plane MN, draw three lines of equal length from the given point P to MN. Draw a circle on MN through the ends of these three lines. Join P to O, the center of the circle. Then PO is the ⊥ required, for equal oblique lines cut off equal distances on the plane when drawn from a point external to the plane, and O is the only point, of course, equidistant from the extremities of the oblique lines. Case 2. If the point is on the given plane, draw a ⊥ from any external point and then draw a ⊥ parallel to this ⊥. If one of two parallel lines is ⊥ to a plane, the other is also.

II. Solution. From the external point P draw any line PC cutting the plane MN in C. In MN draw AB ⊥ PC. At C draw CF ⊥ BA. Then from P draw PQ ⊥ FC. PQ is the required ⊥; for PC, PQ, and CQ are in the same plane, and this plane intersects MN in QC, and is ⊥ to MN. Therefore PQ, a line in one plane, ⊥ to the intersection of the other with it, is ⊥ to the other plane. Case 2 is identical with case 2 in solution I.

Remark by James H. Weaver.

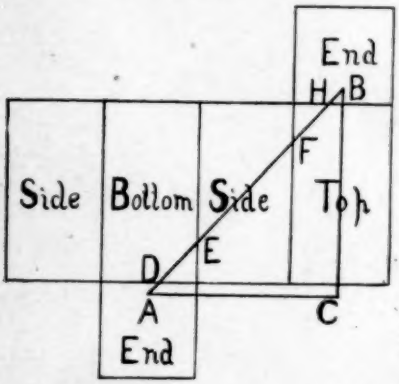
Problem is fully discussed in White's "Elements of Geometry," p. 299.

Miscellaneous.

159. *Proposed by C. M. Woodward, Washington University, St. Louis, Mo.*

A room (without windows or doors to interfere) is 30 feet long, 12 feet wide, and 12 feet high. An electric wire is to be carried, along the ceiling, walls or floor, from a point one foot below the ceiling in the center line of one end, to a point one foot above the floor in the center line of the other end. Required the shortest route and its length.

Solution by G. B. M. Zerr, Ph.D., Philadelphia, Pa.



Let A be the starting point on one end one foot from bottom, B the stopping point on other end one foot from top. Place sides, bottom, ends, and top in the same plane, one end attached to the bottom, the other to the ceiling. Then the shortest route is the hypotenuse of the right triangle ABC, of which AC=24 feet is the base and BC =32 feet is the altitude. $\therefore$ AB =40 feet as follows: 1¼ feet on each end. 8¾ feet on bottom or floor and ceiling respectively, and 20 feet on side.

Discussion by G. E. Congdon, Hiawatha, Kansas.

This problem is discussed in Ball's "Mathematical Recreations," 4th edition, pages 66 and 67. The author of "Canterbury Puzzles," Henry Ernest Dudeney, claims the honor of originating the puzzle, so I quote his exact words propounding the puzzle and giving the solution.

THE SPIDER AND THE FLY.

From "The Canterbury Puzzles" (1908), page 92.

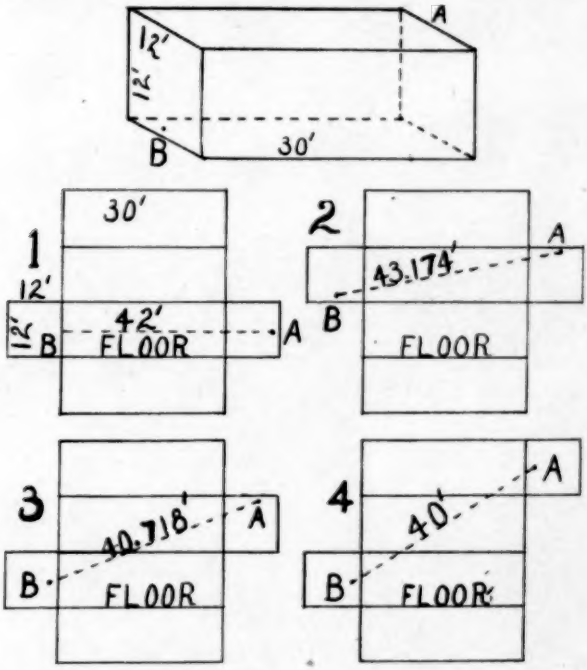
Inside a rectangular room, measuring 30 feet in length and 12 feet in width and height, a spider is at a point on the middle of one of the end walls, 1 foot from the ceiling, as at A, and a fly is on the opposite wall, 1 foot from the floor in the center, as shown at B. What is the shortest distance that the spider must crawl in order to reach the fly, which remains stationary? Of course the spider never drops or uses its web, but crawls fairly.

Solution as given on page 175, same volume.

Though the problem was much discussed in the *Daily Mail* from 18th January to 7th February, 1905, when it appeared to create a public interest, it was actually first propounded by me in the *Weekly Dispatch* of 14th June, 1903.

Imagine the room to be a cardboard box. Then the box may be cut in various ways so that the cardboard may be laid flat on the table. I show four of these ways and indicate in every case the relative positions of the spider and the fly and the straightened course which the spider must take, without going off the cardboard. These are the

four most favorable cases, and it will be found that the shortest route is in No. 4, for it is only 40 feet in length (add the square of 32 to the square of 24 and extract the square root). It will be seen that the spider actually passes along five of the six sides of the room!



Having marked the route, fold the box up (removing the side the spider does not use), and the appearance of the shortest course is rather surprising. If the spider had taken what most persons will consider the obviously shortest route (that shown in No. 1), he would have gone 42 feet! Route No. 2 is 43.174 feet in length, and route No. 3 is 40.718 feet. I will leave the reader to discover what are the shortest routes when the spider and fly are 2, 3, 4, 5, and 6 feet from the ceiling and floor respectively.

Applied Mathematics.

160. *Proposed by W. A. Challacombe, Carlinville, Ill.*

A cord 6 feet long is secured at A and B, 3 feet apart horizontally, and sustains a weight w, attached at C. What must be the length of AC that the tension of AC shall be twice the tension of BC?

Solution by James H. Weaver.

Let AC $= x$, BC $= 6 - x$, angle CAB $= \theta$, CBA $= \phi$, T = tension in BC, 2T=tension in AC. Produce WC to meet AB in D, then CD is perpendicular to AB.

Then $2T = \dfrac{W \cos \phi}{\sin (\theta + \phi)}$, $T = \dfrac{W \cos \theta}{\sin (\theta + \phi)}$, and $\cos \phi = 2 \cos \theta$.

Let AD=y, BD=3—y, then

$\frac{3-y}{6-x}=\frac{2y}{x}$, or $12y-3x=xy$.....(1).

By Geometry $x^2-y^2=(6-x)^2-(3-y)^2$, from which

$4x-2y=9$.....(2).

Solving for x from (1) and (2) we get

$$x=\frac{51\pm 3\sqrt{97}}{8}.$$

The positive value is excluded since it makes x greater than the entire length of cord, therefore

$$x=\frac{51-3\sqrt{97}}{8}=2.68+.$$

CREDIT FOR SOLUTIONS RECEIVED.

Algebra 139. T. E. McKinney. (1).

Algebra 144. Martin Wyngarden. (1).

Algebra 145. Martin Wyngarden. (1).

Algebra 155. Hamlet P. Collins, M. H. Pearson, E. D. Pickering, Orville Price, O. R. Sheldon, James H. Weaver, I. L. Winckler, G. B. M. Zerr. (9).

Geometry 156. Hamlet P. Collins, Orville Price, James H. Weaver, I. L. Winckler, G. B. M. Zerr. (5).

Geometry 157. W. T. Brewer (2 solutions), Hamlet P. Collins, A. M. Harding, E. D. Pickering, Orville Price, James H. Weaver, I. L. Winckler, G. B. M. Zerr. (9).

Geometry 158. Hamlet P. Collins, Veda Belva Larson, M. H. Pearson (2 solutions), Orville Price, James H. Weaver, G. B. M. Zerr. (7).

Miscellaneous 159. G. E. Congdon, G. B. M. Zerr. Also four incorrect solutions. (6).

Applied Mathematics 160. Hamlet P. Collins, Orville Price, James H. Weaver, I. L. Winckler, G. B. M. Zerr. (5).

Total number of solutions, 43.

PROBLEMS FOR SOLUTION.

Algebra.

166. *Proposed by James A. Whitted, Abingdon, Ill.*

Four bonds of $4,000.00 each, bearing 6% interest, dated Sept. 1, 1895, and falling due in 1, 2, 3, 4 years respectively, are sold Oct. 19, 1895. What is the price that they should net the purchaser 5% per annum, compounded annually?

167. *Proposed by H. E. Cobb, Chicago, Ill.*

The first three terms of a series are 1, 7, 19; and the general term, U_n, is an integral function of the second degree in n. Find the general term and the sum of the first n terms.

168. *Proposed by I. L. Winckler, Middlebury, Vt.*

Solve $(y+z)\ (x+y+z)=a$

$(z+x)\ (x+y+z)=b$

$(x+y)\ (x+y+z)=c$

Geometry.

169. *Proposed by B. C. Eastham, Salem, Oregon.*

Given the four sides of a quadrilateral and another line, construct the quadrilateral so that its area will equal the square on the fifth line.

170. *Proposed by H. C. Whitaker, Philadelphia, Pa.*

There is a loaf which is a half sphere of radius r. How thick is the crust baked if the soft part is one-nth of the whole loaf?

Applied Mathematics.

171. *Proposed by W. T. Brewer, Quincy, Ill.*

A hollow copper ball is 8 inches in diameter, and in weight just sufficient to sink to its center in water. If the specific gravity of copper is 8.85, what is the thickness of copper in the ball?

A NATIONAL AWAKENING TO THE NEED OF FOREST PRESERVATION.

"In the last ten years," says the Yearbook of the Department of Agriculture for 1907, "forestry has advanced in this country from an almost unknown science to a useful, growing profession. In that time the number of technically trained foresters has increased from less than a dozen to over 400. Ten years ago there was not a single forest school in the country. Now there are several professional forest schools which rank with those of Europe, and a score more with courses in elementary forestry whose usefulness is steadily growing. Forest lands under management have grown from one or two tracts to many, aggregating 7,503,000 acres, scattered through 39 states. The National Forests have increased from 39,000,000 acres, practically unused and unprotected, to 165,000,000 acres, used, guarded, and improved both in productiveness and accessibility. The number of States which have State forests has increased from 1 to 10; and of those which employ trained foresters from none to 11. The membership of forest associations has increased from 3,600 to 15,800. Ten years ago, except for a few of the foremost botanists, European foresters knew more about American forests than did the people of this country. In Europe they were then using preservatives to prolong the service of beech ties, and so adding from twenty to forty years to their life. Here, on the other hand, scarcely a treated tie had been laid, though there are now 60 treating plants, 27 of which treat ties exclusively, and an engineer who recently returned from Europe reports that both in size and mechanical perfection the treating equipment of this country is ahead of any to be found abroad.

"And yet American forestry has only safely passed the experimental stage and got ready to do something. Action, immediate and vigorous, must be taken if the inevitable famine of wood supplies is to be lessened. We are now using as much wood in a single year as grows in three, with only twenty years' supply of virgin growth in sight. Only the application of forest knowledge with wisdom, method, and energy, in the next ten years, can prevent the starving of national industries for lack of wood."

TIMBER A PROFITABLE CROP.

"The growing of timber as a farm crop has gained a permanent place in American agriculture. Each time a thrifty farmer sees a neighbor cutting a supply of fence posts and obtaining, out of the same stock, enough firewood to pay for the work, or selling on the stump a quantity of saw timber, the product of a far-sighted investment of fifteen, twenty, or twenty-five years ago, he realizes more keenly the importance of the wood crop. A farm without a good woodlot is incomplete.

"Where the rainfall is heavy, the woodlot can be maintained on land not the best for other purposes, while in a region where good land must be selected it is the opinion of experienced men that the trees pay for the ground they occupy in protection to the farmstead, the orchard, or adjoining fields. With the shelter of a windbreak, less feed is required to winter stock, danger to an orchard from late frosts is reduced, and the comfort of the home, as well as its beauty, is greatly increased. Indeed, some owners have estimated the value of good groves at $1,000 an acre, on the ground that the value of their property is increased to that extent by the trees. Where the forest has been given attention the returns have yielded a net profit of $4, $6, and $10 per acre. In every state a share of the farm can be devoted to growing timber with a profit in some cases nearly or quite equal to that obtained from agricultural crops. In addition, protection, the convenience of having farm repair materials at hand, and increase of farm values are secured.

"That forest planting is increasing is evident from the increased demand for planting material. One nurseryman last spring shipped 400,000 jack pine seedlings to Nebraska alone. One order for 10,000 was for planting in the vicinity of the Brunner plantation in Holt County, an example of successful forest planting which has been of high educational value. The Government nursery at Halsey has also been most helpful in determining the adaptability of conifers for planting on sandy soils in Nebraska and adjacent States.

"The State University of Illinois, at Urbana, has an interesting experimental plantation, and the State Normal School at DeKalb has more recently established one.

"Nebraska has begun to reap the fruits of early forest work, and the past year has manifested that many of the apparent failures of former years were in reality important lessons in the selection of proper species and methods of planting under peculiar conditions. The number of students in the different courses of forestry in the University of Nebraska shows a healthy growth. In addition to the regular courses a special course is given for public school teachers, and during the year a course for advanced students and courses of lectures on silvics and State forest policy have been inaugurated. The permanent equipment of the department of forestry has been enlarged, and now includes, among other additions, a forest herbarium, a large collection of wood specimens, and a portable sawmill for practical demonstrations upon the timber grown by provident farmers of that vicinity.

"In Iowa the professor of forestry at the State college carries on experiments and State work. Among the problems now under consideration are the improvement of planted groves and natural woodlots, the determination of what are the most valuable species for general woodlot planting, the best methods of planting and handling the woodlot, and the development of simple methods of preservative treatment which can be carried out economically by the farmer.

"Since the establishment of the Fort Hays experiment station, in west central Kansas, a series of experiments have been begun, in the very center of the Plains region, of growing young trees according to various cultural methods on upland and bottomland on a scale large enough to lend authoritativeness to the results. The State forestry stations at Ogallah and Dodge City are directing their chief efforts to the distribution of young trees in the westernmost counties.

"As a result of coöperative forest studies in the Ozark region of southern Missouri and western Arkansas, between the State of Missouri and lumber companies on the one hand and the Forest Service on the other, one large lumber company which controls in the aggregate four billion feet of standing timber has begun the application of forest management to its holdings."

The article, from which the above are excerpts, gives a brief summary of recent achievement in forestry in the United States, a list of forest laws passed in 1907, and a directory of State forest laws, forest associations, and forest schools. It has been printed as a separate, and can be had free upon application to the Forester, U. S. Department of Agriculture, Washington, D. C.—*Progress of Forestry.*

ARTESIAN WATERS OF FLORIDA.

First Map of Florida Showing Altitudes.

This determination of altitude is of great importance in connection with the exploitation of the artesian waters in the State. Whether or not a flow can be obtained at a particular place, or whether a suction pump can be used in a nonflowing well, depends on the altitude of the place, although other factors, such as nature of the rocks and distance and direction from the central axis of the State, must also be considered. Of course, no intelligent person would expect to get a flowing well at Highland, but at a lower point, like Baldwin, the question is not so easily solved. As an aid to the solution of similar problems, geologists of the United States Geological Survey who have been investigating Florida for the national and state geological surveys for more than a year are preparing a topographic map of the State. On this map the elevations above the sea will be shown by contour lines drawn at intervals of 50 feet, and the areas where flowing waters can be found will be distinctly indicated. This map will serve as a base on which the geologic formations will be delineated, and will be the first map of Florida showing elevations.—*U. S. Geol. Survey.*

SCIENCE QUESTIONS.

FRANKLIN T. JONES,
University School, Cleveland, Ohio.

Readers of SCHOOL SCIENCE *are invited to propose questions for solution—scientific or pedagogical—and to answer the questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Teachers are requested to send copies of their recent examination questions to the Editor of this department. Recently he sent out letters to about 400 schools, receiving about 150 replies, enclosed with which were over 100 sets of questions. Many of these were extremely interesting, a few were very difficult, many were very easy. It is presumed that all represent fair tests of the work done.

Quite a number of replies stated that no examinations were given but that promotion was based on the daily work. This suggests the query as to what is the real function of an examination. Is it to find out how much the pupil knows? If so, a three hour test is too brief. Is it for the purpose of "passing" or "failing" him in a year's work? Is it to find out whether he has studied? Is it to serve as a stimulus to study? Unless it does the last, it is hardly worth while. The examination should not, however, serve as a threat to any but the idle pupil. A fair test is something which the earnest student takes pride in passing, because it means the meeting and overcoming of a difficulty.

Questions and Problems for Solution.

16. *Proposed by C. M. Turton, Chicago, Ill.*

What is meant by the potentiometer method of measuring resistance?

17. *Proposed by Harold B. Reed, Cleveland, Ohio.*

A glass tumbler weighing 200 gm. is cooled from 20°C. to 8°C. when 240 gm. of water at 6°C. are poured into it. Find the specific heat of the glass. (Solve by simple analysis without use of formulæ.)

18. *From an examination paper of the High School, Montclair, N. J.*

Using a meter stick (weight=140 gm.) a boy finds the weight of a trout to be 1260 gm. by suspending the fish from one end of the stick and balancing it on the edge of a knife blade. Find at what point the blade must be placed.

Solutions and Answers.

12. *East High School, Cleveland, examination question.*

Solve without using a formula:

(*a*) What time will be required for a 45 dyne force acting on a 35 gram mass to produce a change of 18 cm. per second in the velocity?

(*b*) A stone falls from a bridge to the water below in 3½ seconds. How high is the bridge?

Solution and remarks by Paul E. Sabine, Worcester, Mass.

(*a*) What time will be required for a force of 45 dynes to produce a change of 18 cms. per second in the velocity of a 35 gm. body?

1 dyne in one second changes the velocity of 1 gm. 1 cm per second.

1 dyne in one second changes the velocity of 35 gms. 1/35 cm. per second.

45 dynes in one second changes the velocity of 35 gms. 45×1/35 or 45/35 cms. per sec.;

To change the velocity 18 cms per sec. would require as many seconds as 45/35 is contained times in 18, or 18÷45/35, 14 secs.

(*b*) A stone falls from a bridge to the water below in 3½ seconds. How high is the bridge?

Every second that a body falls its velocity increases about 32 ft. per second. At this rate of increase, in 3½ seconds the stone's velocity increases 3½×32, or 112 ft. per sec. It started with no initial velocity, so that its average velocity is 56 ft. per sec., or $\frac{0 + 112}{2}$ ft. The distance fallen in 3½ secs. with an average velocity of 56 ft. per sec is 56×3½, or 196 ft.

Apropos of this subject of analytic solution of problems, does it seem to you that the average High School pupil's powers of arithmetical analysis are unduly limited? The awful dilemma of whether to *multiply* or *divide* seems to present almost insurmountable difficulties, I find, to certain pupils. Is this in any way due to the present methods of elementary arithmetic teaching, or must we accept it as the inevitable accompaniment of the mind's disinclination to act?

(*a*) *Solution by H. B. Reed, Cleveland, Ohio.*

By definition	1 dyne	on	1 gm.	for	1 sec.	makes	1	cm./sec.	change.
then	45 dynes	"	"	"	"	"	45	"	"
and	45	"	" 35	"	"	"	45/35	"	"
and	45	"	" 35	"	" x	sec. "	$9/7x$	"	"

But by conditions of the problem the velocity change was to be 18 cm./sec.

$$\therefore\ 9/7x = 18 \text{ and } x = 14.$$

(*b*) 9.8×3½=34.3 velocity at end of 3½ sec. in *m*/sec. Since the start was from rest and acceleration uniform, ½ of 34.3=17.15 average velocity during time in *m*/sec.

Hence 17.15×3½=60.025, distance fallen and height of bridge in meters.

Credit for Solutions Received

12. H. B. Reed, Paul E. Sabine, G. B. M. Zerr. (3)

A memorable meeting was held in Rochester, N. Y., July 8, 1909, when the 1,800 employees of the firm of Bausch and Lomb assembled to present to the firm, by unanimous vote, a bronze and marble tablet as a slight token of the high esteem in which Captain Lomb was held by them. It speaks well for the character of a man when his employees will spontaneously do a thing of this kind. Incidentally it is certificate of character of the great firm of which he was a member.

REAL APPLIED PROBLEMS IN ALGEBRA AND GEOMETRY.

COMMITTEE ON INVESTIGATION: JAMES F. MILLIS, *Chairman, Francis W. Parker School, Chicago;* JOS. V. COLLINS, *State Normal School, Stevens Point, Wis.;* C. I. PALMER, *Armour Institute of Technology, Chicago;* E. FISKE ALLEN, *Teachers College, New York, N. Y.;* A. A. DODD, *Manual Training High School, Kansas City, Mo.*

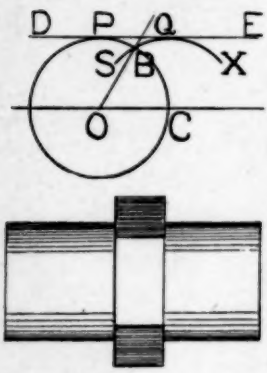
Teachers of mathematics and others who are interested in the movement to reform the teaching of mathematics in the secondary schools by teaching the subjects more in relation to their practical uses are earnestly requested to coöperate with this committee.

All real applied problems of algebra or geometry that are sent to the members of the committee will be printed in these columns, and proper credit given the contributors.

Teachers are requested to use these problems in their classes, and to forward criticisms of them to the committee.

Problems.

By George Arrowsmith, Director Turning, M. T. H. S., Kansas City, Mo.



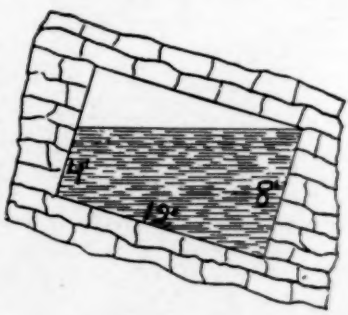
1. It is required to make a regular hexagonal valve pattern which shall be 2¼″ between any two parallel sides. It is claimed that the following construction will give the required cylinder necessary to make the pattern:

With O as center and radius 1⅛″ describe circle. At point C, outer extremity of radius OC, as center, and radius 1⅛″ describe arc SX cutting first circle at B. Draw common tangent DE. Extend radius OB to meet DE at Q. Then OQ is the exact radius required to turn the cylinder necessary to give the regular hexagon. Can this method be proved correct?

By John H. Bortz, High School, Greensburg, Pa.

2. A pile of sawed ties each 8′ by 12″ by 8″ is 8′ long, 6′ wide, and 4⅝′ high. The ties are in layers touching each other and each layer separated by a 2″ board. Find the number of ties and weight. Suppose specific gravity of wood is .8.

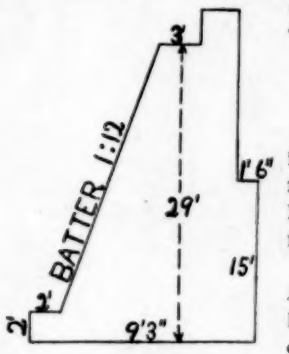
3. In a certain mine there are three one-inch pipes leading from three sumps. It is desired to collect the water into one sump and use one pipe. What size pipe will take the place of the three one-inch pipes?



4. A room in a mine running due north is full of water on the dip side. The dip is due east 1 in 3. If the room is 100 ft. long, 12 ft. wide, and 8 ft. high, what will be

(1) the weight of water in room; (2) the horse power required to raise the water in 5 hours through a shaft 200 ft. deep, allowing 20% for leakage of pumps and 20% for resistance of engine and pipes?

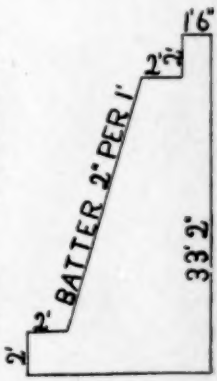
$$\text{H. P.} = \frac{\text{lbs. per min.} \times \text{feet}}{33000}.$$



5. A certain coal and coke company finds it necessary to construct a wharf wall 150 ft. long, having an end section as per figure. How many perches of stone are necessary for the wall?

6. A bin in a warehouse is 12 ft. square. A hopper is constructed on the base which has a slope of 1:1. The distance from apex of hopper to top of bin is 18 ft. Find capacity of bin.

7. Find the cubic contents of a retaining wall 50′ long. Dimensions of section as per figure.



8. A miner drills a hole 2″ in diameter in which he places a certain amount of blasting powder. The gases generated by the explosion have a volume of 36945.216 cu. in. If the volume of the gases is equal to 280 times that of the powder, what is the length of the bore hole, allowing 18′ ft. for tamping?

By G. H. Graves, Horace Mann School, New York, N. Y.

9. The pressure of water at different depths is given by the formula $p = \frac{62.5}{144} h$. Find at what depth there is a pressure of 100 lb. per sq. in. What is the pressure at 230 ft.?

10. The central angle a of a railroad curve of length l ft. and degree d degrees is obtained by the formula $l = 100\frac{a}{d}$. What is the central angle of a 2-degree curve 948 ft. long?

11. Western Price list gives cost per foot of sewer pipe $C = 0.4d^2 + 14$, where d is diameter in inches. What would one-half mile of 16-inch pipe cost?

12. Water in freezing expands 10% of its volume. How much water when frozen will just fill a 5-gallon freezer?

13. At what advance must a shopkeeper mark books costing 90 cents that he may allow 20% discount and yet gain 25%?

14. A man purchases ice at 50 cents per 100 lb. At what rate must he sell it after it has lost 10% of its weight by melting to gain 20%?

15. What is the longitude of a place in the central time belt whose local time is 22 minutes faster than its standard time?

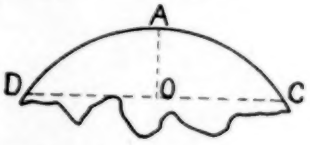
16. Two boys agree to care for a lawn for 12 weeks, for which they are to receive $8. One works ten Saturdays, the other 9, each of course

taking twice as much time on the days that he worked alone. How much of the $8 should go to each?

17. Archimedes suspected a crown of being made of a mixture of copper and gold, and proved it by weighing it and then weighing the water which ran out of a full vessel into which the crown was placed. Suppose that he found the weight of the crown to be 1140 gr. and of the water to be 390 gr., gold being 19.3, and copper 8.9 times as heavy as water, respectively. Find how many cubic centimeters of each metal there was in the crown, and its weight if it had been pure gold.

By W. M. Strader, Teachers College, New York, N. Y.

18. Given a fragment of a water wheel. Construct a new wheel of its size. DC was found by measurement to be 4', and AO to be 1'. Compute the diameter.



By Jos. V. Collins, State Normal School, Stevens Point, Wis.

19. To illustrate proposition that lines drawn parallel to the same line are parallel, give figure showing how lines are drawn parallel on drawing board with T-square.

20. Tell how to construct miter box, that is, how to mark for cuts. See dictionary for description and drawing.

21. Parallel rulers (see dictionary for description and cut) are quadrilaterals made so that two opposite sides are equal and the other two are parallel. Show by geometrical propositions that if the straight-edge sides are parallel in one position, they are parallel in any position.

22. Tell how to mark points of the circumference of a circle by means of a steel square on a given line as diameter.

23. To get miter cuts on miter board with steel square. What relative lengths must be laid off from heel on legs of square from outer edge of one board to get 45° cut? By what proposition in geometry? What lengths shall be laid off to get 30° and 60° angles? Notice that in this case an arbitrary hypotenuse of right triangle will have to be taken.

24. To bisect an angle with a steel square.

25. An organ has 2, 4, 8, ...n registers. How many different sound effects can it yield?

By C. I. Palmer, Armour Institute of Technology, Chicago.

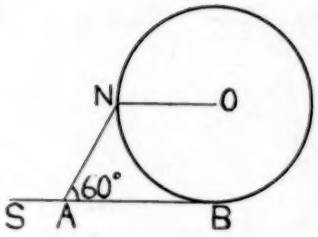
The practical man makes use of a great many "rules of thumb." These rules are usually simple and easy to apply, but it often happens that he wishes to test their accuracy. Test the accuracy of the following and find the per cent of error in each case.

26. The weight of round iron in pounds per foot = the square of the diameter in quarter inches ÷ 6. (Wrought iron weighs 480 pounds per cubic foot.)

27. The weight of flat iron in pounds per foot of length = width in inches times thickness in inches times 10/3.

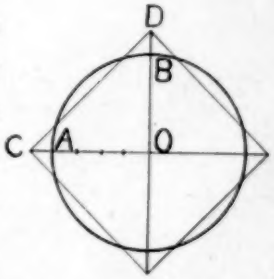
28. .The weight of flat plates per square foot = 5 pounds per ¼ inch in thickness.

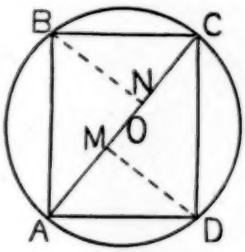
29. The weight of a cast iron ball = the cube of the diameter times .1377. (Cast iron weighs 450 pounds per cubic foot.)



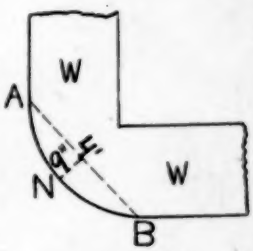
30. To rectify a quadrant of the circle O, draw the radius NO and the parallel tangent SB, then draw AN making an angle of 60° with SB and AB is the quadrant of the circle, nearly.

31. To construct a square equal in area to the circle O, divide the radius into four equal parts, place one of these parts at an extremity of each of two perpendicular diameters, as at AC and BD, then CD is a side of the required square.





32. The method given by Galileo for finding the strongest rectangular beam that can be cut from a round log, is as follows: Let the circle ABCD represent the end of the log, and let AC be a diameter. Divide the diameter into three equal parts at the points M and N, and from these points erect perpendiculars intersecting the circumference at points D and B. Draw AD, DC, CB, and BA. The rectangle thus formed is the cross section of the strongest rectangular beam. Show that the dimensions of the rectangle are in the ratio of $1 : \sqrt{2}$.



33. W, W is a wall with a round corner of dimensions as given in the figure from A to B, on which a molding, gutter, or cornice is to be placed, and it is desired to find the radius of the circle of which the arc ANB is a part.

DISCUSSION OF THE PRACTICAL USE OF BIOLOGY.

By Herbert S. Smith,

Forest Service, Washington.

The report on "The Practical Use of Biology," published in School Science and Mathematics for February, is to my mind profoundly suggestive for all who are interested in our educational system. To those of us whose work concerns the best use of any of our natural resources in the interest of the public welfare, the principles set forth in this report seem fundamental, while the fact that they have been formulated by a representative committee of science teachers is one of the most significant and most encouraging signs of the times.

Back of all educational methods and theories lies the fact that our public schools are maintained to prepare for citizenship and for life. The report of the committee points out how better preparation for life calls for science teaching with an altered aim. It points out also how the need of protecting the public welfare calls no less strongly upon the science teacher to make clear the effects of misuse of our natural resources. Thus is frankly accepted a moral as well as an economic end. To me it seems that science itself makes such a conclusion inevitable.

For it is science itself which through the study of man's relation to his environment is bringing us to a new viewpoint. As against the old conception of history which regards man as a free agent arose the scientific conception of man as controlled by environment. Under primitive conditions not only social life and institutions but even the individual life was within narrow limits fully subject to the play of nature's forces. With knowledge, however, man advanced in mastery over nature. Instead of being controlled by physical conditions the individual has to a large extent learned how to control those conditions. But society is still controlled by conditions. The sciences of biology and geography applied to human history and life are making clear just how natural conditions have molded human welfare, and how human action has affected natural conditions, not with design, but as one of the causes at work.

It follows irresistibly that the investigations of science along these lines holds up to us practical conclusions. There is a need of intelligence as a guiding principle for the securing of the *collective* welfare in man's relation with his environment.

The whole history of life is the history of progress toward freedom. From inorganic matter all the way up the evolutionary scale appears emancipation from outward necessity. Step by step, from crystal to plant, plant to animal, animal to man, the control of external law becomes apparently less absolute, the play of individuality greater. It is now plain that another advance lies open to man through public action to control, so far as possible, the physical environment both against evil results of human activity and in favor of the largest usefulness in the long run. But this result can be brought about only through public education as to the relation between man and natural resources. For my own part I believe that this should be one of the great ends of the teaching of science in our schools.

NOTES ON QUERY CONCERNING DIVISION.

WM. B. BORGERS,

Grand Rapids, Mich.

It cannot be too clearly borne in mind by the teacher (not by the elementary pupil), that "Division is the process of finding one of two factors when the other factor and the product are given." Since the children were told to separate the six dots into groups by twos, therefore two was the factor given, and they were dividing by two. "The given factor is the divisor, and the required factor is the quotient." Three times two cents is six cents. That is, two cents and three are the factors of the product, six cents. If the pupils are asked to find the number of stamps, then the factor two cents must be given, and that is the divisor. Dropping the names of the concrete numbers, this becomes dividing six by two. Perhaps there may be room for debate when you lack a definition for division, but with the above definition there is nothing left to debate. This definition, however, need not be taught to primary children. Neither need the beginners be taught that they are "dividing six by" either two or three. In the case of dividing the six dots into groups by twos, they are to "find how many twos make six." When they reach the stage where it is first necessary to speak of dividing six by one of the numbers, the teacher knows that they are to divide by two. And if a pupil raises a question, it is easily answered by saying, "Two was the number I gave you to divide by. How could you divide by three before you had found that three was the other number?" This would be still more conclusive if the quotient were not so well known; and the question need never come up till the children are dividing say 75 by 5, where they really will not know the "other number" until they have divided. The teacher of the earliest beginners in number should know what division is, and know when she is dividing six by two or by three. But she should not teach this to her pupils till they have had enough examples of division to make the term stand for a familiar thing; it should not be an unknown word standing for an unknown, or even for a new thing.

As a corollary to the above, though the question did not touch on this point, no definitions should be taught for addition, subtraction, or multiplication, at least until high school algebra is reached. Such definitions are in every respect as futile and absurd as to explain "He went away back and sat down," to mean "He retired to the extreme rear and assumed a semirecumbent position." If the child does not know what going back and sitting down means, the only way he can learn is by being shown. If he does not know what addition is, the only way to teach him is to give him some examples. Any definition cannot possibly help him. This is especially the case with such a definition as "Multiplication is the process of taking one number as many times as there are units in another." Even if this did make anything clearer, it is not true. How can you do anything one-third times? If you can assign any meaning to such a phrase, you will know how to multiply by one third. But your knowledge did not come from that definition, nor can any knowledge come from it.

COMMENTS ON DIVISION IN ARITHMETIC.

By L. Leland Locke,

Brooklyn, N. Y.

The three inverse operations of arithmetic, subtraction, division, and square root (as a particular case of evolution) are each two-phased. With square root, the double sign indicates this quality.

Subtraction may be considered from two viewpoints, depending on the problem proposed:

(1) When the subtrahend was originally a part of the minuend as in the following problem: John has 15 marbles and gives Harry 3 marbles. How many marbles has John remaining? In the case where the number in any order in the minuend is less than the number in the same order in the subtrahend, the method called Decomposition is used. "Take one from the next higher order in the minuend," etc.

(2) When the minuend and subtrahend are two distinct numbers and it is required to find their difference, as in the following: John has 15 marbles and Harry has 3 marbles. How many more marbles has John than Harry?

In the case above, the method of equal additions is applicable. Add 10 to the order in the minuend and 1 to the next higher order in the subtrahend.

The two phases of division may be seen by considering the operation of which it is the inverse.

Three marbles are given to each of 5 boys. How many marbles are required. The multiplicand (3 marbles) and the product (15 marbles) are alike, that is, each is measured by the same unit (1 marble), and the multiplier is *abstract* (the *number* of boys). In division the product of the multiplication problem becomes the dividend, and the divisor may be either the multiplier or the multiplicand. In the first case the problem would be stated: 15 marbles are to be divided among 5 boys. How many marbles does each boy receive? The dividend is to be divided into 5 equal parts. The quotient will be *like* the dividend. This process is called partition. To be uninfluenced in the solution, suppose the result unknown. We would begin by giving each boy 1 marble and continue until the marbles have been disposed of.

Suppose 17 apples are to be divided among 5 boys. Proceed in the same way until 2 apples remain. Divide each of the 2 apples into 5 equal parts and again start the distribution with the new unit. If the dividend is a continuous magnitude, as a segment of a line to be divided into n equal parts, the ordinary geometrical construction is used.

In the second case, 15 apples are to be divided so as to give each boy 3 apples. How many boys? This problem is to measure 15 apples with the unit 3 apples and would be solved by giving the first boy 3 apples, and so on. The result is 5, the number of boys. This process is called subtractional division or measurement. It is the inverse of multiplication considered as repeated addition. With continuous magnitude it is the process used in measuring a web of cloth with a

yard stick. In case the elements are abstract numbers no distinction is needed.

The grouping of the dots cited by the writer of the article in the May number may be arrived at in both ways, separation into 3 equal groups, giving as an answer, 2 dots; or measuring 6 dots with the unit 2 dots, giving the abstract 3 as an answer.

The first grade teacher will render her position tenable if she says "divide by 2 *dots*." The upper grade teacher has lost sight of the fact that the result is not the grouped dots but the abstract number 3. If one is given 6 dots arranged in 2's, it is as absurd to declare that the grouping was accomplished in a particular way as to assume that because a man traveled from New York to Chicago he passed through Buffalo.

The wisdom of the use of the words combination and separation for addition and subtraction is to be doubted. There is no material gain in shorter words, and the others must be given later.

THE REPORT OF THE FIRST MEETING OF THE NORTH DAKOTA ACADEMY OF SCIENCES.

The first meeting of this Academy was held at the University in Grand Forks May 21st. Dean Brannon of the University Medical College presided and L. B. McMullen of the Valley City Normal School acted as Secretary. Having transacted the business of the meeting the regular program was taken up. The first paper was one on "The Biological Opportunities in North Dakota," by Dean Brannon. He pointed out the various fields of activities which might be taken up by the Biology teachers of the State. This paper was followed by those of Professor McMullen and Dr. Stewart on the subject, "In What Way can those Engaged in Physics be of Service to the State?" Both of these papers were to the point and contained many helpful suggestions to Physics teachers. Dr. Young of the University then read a paper on "The Zoölogical Outlook in North Dakota." Dr. G. F. Ruedger, director of the North Dakota Public Health Laboratory, presented a paper on "Studies on Self Purification of Streams." This was a valuable paper and contained many helpful suggestions. Prof. C. B. Waldron's paper on "Some Scientific Aspects of the Forestry Problem in North Dakota" was well received and contained helpful points that all inhabitants of the State ought to know about.

Dr. Leonard, director of the North Dakota Geological Survey, read a paper on "The Relation of the Academy of Science to North Dakota from the Standpoint of Geologists." This, too, was a valuable paper. Since Dakota is so largely endowed from a geological point of view. Prof. G. A. Abbott of the Agricultural College and Prof. E. J. Babcock of the University both read papers on Chemistry Problems of the Academy.

This initial meeting of the Academy created much interest among those who were in attendance, and the papers read were of an exceptionally high character. It is believed that the momentum gained at this meeting will be the means of bringing the Science men of the State in closer touch with one another and thus be able to better develop the cause of Science in North Dakota. C. H. S.

THE UNIT IN BOTANY.

A Report of a Meeting of the Committee of the North Central Association of Colleges and Secondary Schools upon the Definition of the Unit in Botany for the North Central Association of Colleges and Secondary Schools.

The committee consists of the following members:

O. W. Caldwell (Chairman), Associate Professor of Botany, University of Chicago, Chicago, Illinois.

F. C. Newcombe, Professor of Botany, University of Michigan, Ann Arbor, Michigan.

L. Murbach, Head of the Department of Biology, Central High School, Detroit, Michigan.

C. R. Barnes, Professor of Plant Physiology, University of Chicago, Chicago, Illinois.

R. A. Harper, Professor of Botany, University of Wisconsin, Madison, Wisconsin.

M. F. Arey, Professor of Natural Science, Iowa State Normal School, Cedar Falls, Iowa.

C. E. Bessey, Professor of Botany, University of Nebraska, Lincoln, Nebraska.

E. A. Boostrom, Superintendent of Schools, Osceola, Nebraska.

Eloise Butler, Teacher of Botany, South Side High School, Minneapolis, Minnesota.

Francis Ramaley, Professor of Biology, University of Colorado, Boulder, Colorado.

Ellsworth Bethel, Teacher of Botany, East Side High School, Denver, Colorado.

Grace J. Baird, Teacher of Botany, High School, Urbana, Illinois.

Etta M. Bardwell, Teacher of Botany, High School, Cedar Rapids, Iowa.

J. F. Garber, Teacher of Botany, Yeatman High School, St. Louis, Missouri.

A. F. Ewers, Teacher of Botany, High School, Davenport, Iowa.

Wm. P. Holt, Teacher of Botany, High School, Toledo, Ohio.

Russeau McClellan, Head of Department of Biology, Shortridge High School, Indianapolis, Indiana.

Ellen T. Sullivan, Teacher of Botany, High School, Appleton, Wisconsin.

Royden E. Webster, Teacher of Botany, High School, Iron Mountain, Michigan.

Worrallo W. Whitney, Teacher of Botany, South Chicago High School, Chicago, Illinois.

Benjamin M. Davis, Professor Agricultural Education, Miami University, Oxford, Ohio.

Elma Chandler, Teacher of Botany, Soldan High School, St. Louis, Missouri.

The committee met in the Botany Building of the University of Chicago on June 26th, 1909. The following members were present:

Caldwell (chairman), Barnes, Newcombe, Whitney, Garber, Holt, Miss Baird, Miss McClellan, Miss Chandler, Miss Sullivan, Ewers, Webster, Davis, Miss Leavitt of Minneapolis representing Miss Butler.

The following additional members, who were not in attendance had sent written statements of their views in response to letters sent out by the chairman:

Murbach, Bardwell, Harper, Arey, Bessey.

Dr. Caldwell, the chairman of the committee, briefly outlined (1) the purpose of the meeting which is to reconsider the statement of the unit, and (2) called attention to previous reports of the committee, and (3) to the reason for enlargement of the committee, which is to secure more adequate representation of teachers actually engaged in teaching botany in high schools.

Dr. Barnes was called upon by the chairman to speak upon the "Purposes of the Course in Botany." Dr. Barnes stated that the main purposes of the course are primarily (1) to develop the scientific attitude of mind and a judicial temperament, to think straight and clearly, and (2) to widen the student's horizon or to increase his fund of information; or (briefly summarized) (1) training, (2) information. That it is comparatively simple to state the purposes of the course but difficult to know how to accomplish these ends.

To begin with things in which *all* students are interested, Dr. Barnes declared would be difficult since there are many students and many interests. While this mode of starting the course might apply to an ideal case of one teacher to *each* pupil, it would not apply to the average school. Some general plan must therefore be pursued in the presentation of the work regardless of the initial interests of the students.

After brief discussion of the above it was moved by Dr. Newcombe, that the ideas of (1) training, (2) information, or "the broadening of the student's horizon," be accepted by the committee to represent their views as to the purpose of the botany course. Carried unanimously.

Dr. Caldwell raised the question of the desirability of introducing into the botany course such subjects and materials from applied botany as would have a special bearing upon agriculture and other industries. Botany needs plenty of meaningful illustrative material, which would be of appreciable value to the student and of the highest scientific value.

The chairman read letters from Dr. Harper of the University of Wisconsin, and others in which was emphasized the undesirability of substituting a hodge-podge of elementary agriculture in place of a substantial general course in botany.

Whether the matter of plant breeding should be introduced *experimentally* was questioned by Dr. Newcombe. It was generally conceded, however, that a limited reading knowledge of the subject is desirable.

The general trend of the discussion, in which several participated, in regard to introducing more subjects and illustrative material from agriculture, forestry, horticulture, etc., was that less stress should be placed on morphology and taxonomy in the course, and that a better use be made of local materials, and that the various economic phases

of botany be more carefully considered, thus bringing the student more closely and intelligently in touch with his environment.

Mr. Whitney called attention to the danger of overcrowding the course by grafting on the new and still retaining the old. While he accepted as highly desirable certain of the proposed changes to make better use of local material, and of emphasizing certain economic phases of the work, he foresaw a danger in adding new work to the course *without* a corresponding elimination of an equal amount of less desirable work that is included in the botany course at present.

It was moved and carried that a committee be appointed to outline the principal content of a year's course in high school botany.

Before the close of the morning session it was moved, seconded, and carried that a subcommittee, of which Dr. Caldwell should be the chairman, be appointed to prepare and present to the afternoon session a tentative plan for a new statement of the unit. The other members of the subcommittee appointed were W. W. Whitney, B. M. Davis, and W. P. Holt. Adjournment was taken until 2 o'clock P. M.

Afternoon Session.

The subcommittee appointed to prepare a tentative plan for a year's work in botany, presented a partial report on the content of the year's work. In the discussion that followed it was moved by Dr. Barnes that the definition of the unit in botany be made in rather general terms, and be accompanied by a statement as to the qualifications for teachers who should be approved by the North Central Association. Carried.

It was further recommended that there be prepared, to accompany the more general statement of the unit, a list of subjects and exercises that might reasonably make up the content of a year's course. This was not, however, to be in the nature of a requirement, but was intended to serve as a helpful guide to teachers who might desire a statement as to what should be included in a year's course that would be entitled to the unit of credit.

It was moved and unanimously carried that work should be outlined for a year's credit only. No provision was made for the recognition of less than a year's work in botany.

Dr. Barnes moved that the equivalent of 180 periods of 45 minutes each, in the clear, be the time requirement for the class room; and that double laboratory periods count as one recitation period. Carried. It was further moved by Dr. Newcombe that there be recommended three double laboratory periods a week, at least two being prescribed. Carried.

Recommendation was made that the high school botany be not given before the second year of the high school course. Carried.

As to the general content of the course the following recommendations were made by motions which were carried:

That Plant Physiology should be one of the large subjects included; that the relations of plants to man be emphasized throughout the course; that Plant Ecology, including field work, should be a part of the course. That the study of the great groups of plants, including the

"lower forms" as well as the seed plants, together with some of the leading families of seed plants, be included in the course.

Motion was made that Dr. Caldwell be requested to complete, with such assistance as he may desire to secure, a rather detailed statement of the subjects and exercises that would be desirable in a year's course in high school botany. Carried.

In an informal discussion on the qualifications of the teacher, in which everyone present was called upon to express opinions, it was suggested that the well-equipped high school teacher in botany should have as a minimum the following preparation—at least two years of botanical study including the Morphology of the lower and higher plant forms, Plant Physiology, Ecology, including a thorough knowledge of the flora in the region where taught, Plant Diseases, and a general course in Bacteriology. Some work in Zoölogy and Physiography was further recommended as desirable. While these preparatory studies for the teacher were deemed highly desirable, it was recognized that only a very small part of the present force of teachers in secondary schools could qualify on this standard.

It was moved by Mr. Whitney that the chairman appoint a special committee to serve with the chairman in summing up and elaborating the suggestions made in this meeting. Carried. The members added to the committee were W. W. Whitney, B. M. Davis, and W. P. Holt.

A list of special topics, prepared by Mr. Whitney and Mr. Holt, as desirable subjects to be introduced into the botany course, were referred to the committee just appointed.

Moved and carried that the secretary be instructed to send to each member of the committee a general statement of the expense in connection with the work of this committee and that each member of the general commitee pay $1.00 toward carrying on the work. Carried.

OTIS W. CALDWELL, Chairman.
WM. P. HOLT, Secretary.

THE REPORT OF THE JOINT MEETING OF THE PHYSICS CLUB OF NEW YORK, AND EASTERN ASSOCIATION OF PHYSICS TEACHERS.

This meeting was held in Hartford, Conn., on Saturday, April 24th. The meeting was called to order by the President, N. Henry Black of the Eastern Association, and the Secretary's report of the last meeting was accepted. Mr. Clement C. Hyde of the Hartford High School, who has had considerable experience in the manufacture of apparatus from second hand material, said something about his work and announced that the laboratories containing this apparatus were open for inspection. Mr. Chas. R. Herrick, Chairman of the Committee on Magazine Literature, presented his report. Mr. Roger C. Chittenden, Chairman of the Committee on Current Events, presented a very interesting and helpful report. Mr. J. W. Hutchins, Chairman of the Committee to investigate the teaching of Physics in small high schools,

made his report, after which Mr. Frank B. Spaulding, a member of the committee of Secondary School Teachers appointed by the College Entrance Examination Board to define the unit in Physics, then spoke concerning the work of this Committee. (The complete report of the Committee appeared in the June number of this Journal). Then came the report of Reviews of Books. Mr. Spaulding then read an interesting paper on the Culture Aim in Physics Teaching. The subject of a Physics course for girls was then discussed by Mr. W. G. Whitman of the Ethical Culture High School of New York City, Mr. Frank A. Waterman, and by Irving H. Upton. The meeting then adjourned for luncheon which was served at Hotel Garde.

The afternoon session was called to order by the President of the New York Physics Club, Mr. Frank B. Spaulding. Messrs. John A. Clark and Calvin H. Andrews discussed the question "Adaptation of Physics to Commercial Course Students." These papers were followed by one on "Adaptation to the Work in Physics to the Needs of Manual Training Students," and was discussed by Messrs. MacLeod and Raymond B. Brownlee. Prof. E. H. Hall then made some remarks concerning certain laboratory exercises. At the conclusion of Dr. Hall's remarks a vote of thanks was extended to Mr. Hyde and all others who had assisted in any way in making the meeting at Hartford so pleasant and successful.

C. H. S.

NATURAL SCIENCE SECTION OF THE ONTARIO EDUCATIONAL ASSOCIATION.

The Natural Science Section of this organization held a three days' session during the Easter holidays. Several important topics were discussed, among others was the president's address on "High School Science and the Universities;" it was timely and filled with helpful suggestions. This paper was followed by one on "Uses of Literary Studies in High School Education," by W. J. Alexander. The first paper at the Wednesday afternoon session was given by L. H. Graham on the subject "Practical Science Methods." The paper was followed by discussions; first, "On Conducting Chemical Experiments," by W. Donaldson; second, "The Student and Apparatus," by G. A. Carefoot; third, "Collecting and Preserving Botanical Material," by J. H. Faull; and fourth, "On Museum Work in Zoölogy," by B. A. Bensley. This session was followed by a conference with the Home Science Section.

The Thursday sessions took up the discussion of the New Curriculum in Elementary Science, the leaders being J. B. Turner, T. J. Ivey, A. Smith, and L. Stephenson. The talks were spirited, objections being brought forward to some part of the curriculum.

The election of officers for the following year resulted as follows: Hon. Pres., Dr. J. H. Faull; Pres., L. H. Graham; Vice-Pres., D. Whyte; Sec.-Treas., F. J. Johnston; councilors, Messrs. A. P. Gundry, E. Morrison, R. A. Brunt, J. F. Calvert, A. Smith.

ARTICLES IN CURRENT MAGAZINES.

Condor for July-August: "An Annotated List of the Birds of the Barr Lake District, Adams County, Colorado" (with six photos), L. J. Hersey and Robt. B. Rockwell; "Nesting of *Diomedea nigripes* and *D. immutabilis* on Midway Islands," Dr. T. W. Richards, U. S. Navy; "The Only Known Breeding Ground of *Crexicus coturniculus*" (with two photos), A. M. Ingersoll; "Nest of the California Bi-colored Blackbird" (with one photo), Joseph Mailliard; "The Little Brown Crane in California," J. Grinnell; "Nesting of the Arizona Junco" (with one photo), Frank C. Willard; "Nesting Habits of the Rufous-crowned Sparrow" (with two photos), Harriet Williams Meyers.

Conservation for August: "The Everglades of Florida and the Landes of France," by Dr. John Gifford; "Opening of the Coeur D'Alene Reservation;" "Influence of Taxation on Forest Distribution," by E. M. Hoover; "State Forest Policy," by Herman Haupt Chapman; "Theodore Roosevelt, Dynamic Geographer," by Frank Buffington Vrooman; "The Equalizing Influence of Forests on the Flow of Streams and Their Value as a Means of Improving Navigation," by George F. Swain, LL.D.

Photo-Era for August: "Photography Afield," David J. Cook; "Copying Pictures by Photography," Wm. S. Davis; "Practical Telephotography," Stephen E. Woodbury; "The Dresden Photographic Exposition," E. O. Hoppé, F. R. P. S.

Popular Science Monthly for August: "The Future of Astronomy," Edward C. Pickering; "The Future of Mathematics," G. A. Miller; "The 'Druid Stones' of Brittany," J. S. Kingsley; "The Origin of the Nervous System and its Appropriation of Effectors," G. H. Parker; "The Variational Factor in Handwriting," Dr. June E. Downey; "Jane Lathrop Stanford," President David Starr Jordan; "Life from the Biologist's Standpoint," William E. Ritter; "Josiah Willard Gibbs and his Relation to Modern Science," Dr. Fielding H. Garrison.

Journal of Geography for June: "Physiography—An Elementry Science Course in the High School," Harold W. Fairbanks; "The Climate of Cleveland, Ohio," W. M. Gregory.

Nature-Study Review for May: "Attitude of Nature-Study Teacher Toward Life and Death," Anna B. Comstock; "A Neglected Side of Nature-Study (Physical)," R. C. Peck; "Nature-Study in Primary Grades," S. Silcox; "Correlation of Nature-Study and High-School Biology," G. W. Hunter; "Relations of Botany and Nature-Study," W. N. Clute.

Psychological Clinic for June: "Irregular Attendance in the Primary Grades," Ralph L. Johnson; "A Simple and Practical Test of Hearing," E. A. Kirkpatrick; "Our Schoolhouses," William E. Chancellor; "The Effect of School Room Temperature on the Work of Pupils," Linnaeus N. Hines.

Physical Review for July: "Some Electrical Properties of Selenium—I," Louise S. McDowell; "On the Rotation of Constant Deviation Prisms," H. S. Uhler; "The Electrolytic Detector, Studied with the Air of an Oscillograph," George W. Pierce; "The Dependence of the Photo-Electric Current on Light Intensity," F. K. Richtmyer.

Scientific Supplement for July 31: "Carbon Dioxide and Chimney Losses," James E. Steely; "The Costliest Railroad in America," J. O. Lewis; "The Microscope in Engineering," Walter Rosenhain; "Liquid Illuminating and Fuel Gas," O. Bechstein; "Animal Fillers and Strainers," Dr. Enoch Zander. For August 7: "The Calculation of Electromagnets," M. Kennett; "The Messina Earthquake and the Events Preceding it," John C. Soley; Ornamental Fishes," Berthold Koerting.

Zeitschrift für den Physikalischen und Chemischen Unterricht for July: A. Höfler, "Die neuen österreichischen Lehrpläne für Physik;" E. Schulze, "Die beiden parallelen Versuchsreihen zur Ermittelung fundamentaler Sätze der Mechanik;" A. Wendler, "Ein Umkehr-Volumeter zur Raumbestimmung kleiner Körper;" H. Schnell, "Zur Interpretation eines Versuchs von Drude zur Demonstration von Kondensatorschwingungen." Kleine Mitteilungen: B. König und J. Zupanec, "Eine Quecksilberdampflampe für Schulversuche;" O. Ohmann, "Uber eine eigentümliche Leuchterscheinung in einem Gebirgstal;" H. Rebenstorff, "Versuche über Molekularanziehung mit Farbstoff lösungen;" R. Kempf, "Zur Demonstration der Wassersynthese;" Für die Praxis, B. Kolbe, "Die Gewinnung des Sonnenblumenmarks."

BOOKS RECEIVED.

How to Identify the Stars, by Willis I. Milham, Williams College. Pages, 38; illustrated; price, 75 cents net. The Macmillan Company, New York.

Light and Sound, by Wm. S. Franklin and Barry Macnult, Lehigh University. Pages, viii+344; illustrated; price, $1.60 net. The Macmillan Company, New York.

Geology of the City of New York, by L. P. Gratacap, American Museum of Natural History; pages, x+232; illustrated; price, $2.50 net. Henry Holt and Company, New York.

One Hundred Experiments in Elementary Agriculture of the California Schools, by Reilly O. Johnson, Chico, California.

The Teaching of Arithmetic, by Alva W. Stamper, Ph.D., State Normal School, Chico, Calif. 80 pages. Normal Junior Press, Chico, California.

Introduction to Practical Mathematics, by F. M. Saxelby, Head of the Department of Mathematics at Battersea Polytechnic. 220 pages. 12½ cm. by 18½ cm. Longmans, Green, and Company, New York.

History of Common School Education: An Outline Sketch by Lewis F. Anderson, State Normal School, Marquette, Mich. 308 pages 12½ cm.×19 cm. Price, $1.25. Henry Holt & Company, New York.

Integrals of Mechanics, by Oliver C. Lester, Professor of Physics, University of Colorado. 8 mo. Cloth. 67 pages. Diagrams. Mailing price, 90 cents. Ginn & Company, Chicago.

The Elements of Hygiene in Schools, by Isabel McIsaac. 172 pages. Price, 60 cents. The Macmillan Company, Chicago.

An Elementary Text Book, Part II, Sound, by R. W. Stewart, with illustrations, 137 pages. J. P. Lippincott & Company, Philadelphia.

The Evolution of Forces, by Dr. Gustav L. E. Bon; with figures. 388 pages. D. Appleton & Company, New York.

Our Insect Friends and Enemies, by John B. Smith, Rutgers College, pages 314. Price, $1.50 net. J. B. Lippincott Company, Philadelphia.

New Elementary Arithmetic, by George Wentworth; pages viii+254. Ginn & Co., Chicago.

Complete Arithmetic, by George Wentworth and David Eugene Smith, pages v+474. Ginn & Co., Chicago.

The Trees and Shrubs of San Antonio and Vicinity, by Bernard Mackensen; pages, 50; published by author, San Antonio.

Plane and Spherical Trigonometry, by William A. Granville, Yale University; 8vo; pages, xi+302. List price, $2.50. Ginn & Company, Boston.

Elementary Modern Chemistry, by Wilhelm Ostwald and Harry W. Morse. 12mo., cloth. 291 pages; illustrated. Mailing price, $1.10. Ginn & Co., Boston.

Experimental Dairy Bacteriology, by H. L. Russell and E. G. Hastings. 12 mo., cloth, 147 pages, illustrated. Mailing price, $1.05. Ginn & Company, Boston.

General Chemistry for Colleges, by Alexander Smith, Professor of Chemistry and Director of General and Physical Chemistry in the University of Chicago. New York, The Century Co., 1908. 529 pages, 67 figures.

This work, as its author states, is intended for pupils who can devote less time to the study than is demanded by his "Introduction." While intended for college students it is a book that could be studied and used for frequent reference by teachers in secondary schools: to greater advantage than any work of equal volume known to the reviewer. In the arrangement of the contents and the method of treatment especially the clear manner of presenting theoretical topics, and repeated reference to related matter already studied, the user of this book will find satisfaction. The book contains very few typographical errors, is carefully indexed, and as thoroughly up to date as any text-book on the subject with which the writer is acquainted. A. L. S.

The Life of Animals (Mammals), second edition, by Ernest Ingersoll. 555 pages. The Macmillan Company, New York. 1907.

"The Life of Animals" is a book on the natural history of mammals. It is evident that Mr. Ingersoll's preparation for writing this book was very thorough. This is shown by the descriptions of the habits of little known mammals and by the fresh information about familiar ones. A wide range of authorities, scientific, and trustworthy travelers, yield an immense store of information which the author has culled with great skill. Aside from the interesting facts and the entertaining style, the treatment of the *whole* animal, including relationships and geological history, will commend the book to critical readers.

With the passing of the wave of excitable "nature psychology," it is worth while to note that Mr. Ingersoll has made valuable contributions in his books to the formulation of this important idea: The real truth about nature is more wonderful and more interesting than anything *different* from the real truth. H. R. L.

An Elementary Text Book of Physics, Part II, Sound, by R. W. Stewart, with illustrations. 137 pages. Price, $1.25 net. J. P. Lippincott & Company, Philadelphia.

This is a splendid little book on the subject of "Sound" and is written in such clear and convincing language that it might be used as a text book in most of our American secondary schools. The mathematics in it is such that the equations may be readily understood by any third year secondary pupil. As the author says, "The book is complete in itself, and a knowledge of dynamics is necessarily assumed." The book is divided into nine chapters headed—Simple Harmonic Vibrations; Production of Sound; Wave Motion; Propagation of Sound; Characteristics of Sound; Reflection and Refraction of Sound; Velocity of Sound in Air and Water; Transverse Vibration of Strings; Longitudinal Vibrations of Rods and Columns of Air. A complete index accompanies the book. The type is large and clear and the mechanical work is excellent. C. H. S.

Elementary Text Book of Physics, Part III, Light, by R. Wallace Stewart, Doctor of Science (London). Just published. 142 illustrations. J. B. Lippincott Company, Philadelphia.

This volume just issued as Part III of an Elementary Text Book of Physics deals primarily with the elements of geometrical optics. The work is of strictly elementary character and deals with the fundamental ground work of the subject and is a book which if not used as a text should be in the Physics Library of every secondary school. The experiments given in the text are of such a character that they may be performed without any difficulty by the average student of Physics in the secondary schools. The line and point method for geometrical work and most of the experiments in Refraction is adopted. Since in this subject good drawings are so essential, a large number of accurate drawings are given. The book is divided into eight chapters, the first one on Introduction; the second, Rectilinear Propagation of Light; third, Photometry; fourth, Reflection from Plane Surfaces; fifth, Reflection at Spherical surfaces; sixth, Refraction; seventh, Refraction Through Lenses, and the eighth Dispersion. Mechanically the book is well made and printed in an attractive manner and is not only a very readable but a very teachable book.

C. H. S.

The Gulick Hygiene Series, Book IV, The Body at Work, by Francis Gulick Jewett, 12 mo. Cloth, xvi plus 247 pages. Illustrated. List price, 50 cents; postpaid, 60 cents. Ginn & Company, Chicago.

Those who are familiar with this series of books will find in this particular volume matters of Physiology treated which were too difficult to be discussed in "Good Health." The book is profusely illustrated by new and up-to-date cuts. The drawings representing muscles, heart, skeleton, and cross-sections of the bones are remarkably well executed. In presenting the function and structure of bone and muscle this book brings out the advantages and disadvantages of bone and muscle habits, that is, the way in which one uses his body, as to the right and wrong habits of sitting, standing, and walking, laws of muscle and bone by which bad habits of posture may be eliminated and good habits suggested. Good and strong advice is given as to the best methods of exercising the body. The reader is given the information concerning the organs of respiration and digestion, the action of the juices of the alimentary canal on the food, and the change from solid to liquid digestion, the quantity of food required, and the importance of thoroughly masticating it, the evil effects of rapid eating. Over-exhaustion and a morose disposition are discussed. The construction of the heart, lungs, and blood vessels receive attention, and the book also discusses the effect of alcohol, tobacco, and narcotics and other drugs upon the body. As with all text books now issued by this firm the mechanical work is good. It is printed in a large, heavy type, contains fifteen pages of questions divided into paragraphs corresponding to the twenty-seven chapters into which the book is divided. There is a glossary of terms used given with a complete index. We bespeak a large sale for it.

C. H. S.

History of Common School Education, by Lewis F. Anderson, State Normal School, Marquette, Mich. Pages xii+308. Price, $1.25. Henry Holt & Company, New York.

The person who wishes to secure a working knowledge of the development of common school education will find in this book information which will enable him to become familiar quickly with this important phase of education. As the author says, "the book aims to give, as clearly, concisely, and concretely as possible, such information regarding the history and development of the common school as will aid teachers and others to an intelligent understanding of the common school of to-day, its nature and functions, its relations to other institutions, educational and otherwise." The author deserves the thanks of all teachers for the admirable manner in which he has brought together facts covering such a long period, analyzed and arranged them in such an intelligent and readable way. The book traces the influence of the development of the school upon the social life of the early Greeks, the influence of the schools of Alexandria and the effect of the school upon the Roman government. From the days of Rome down to the present date the conditions of the schools are briefly but splendidly described. The book contains thirty-one chapters, nearly every one being divided into heads under which the discussions are carried out. There is a very complete index of seven pages. The type is large and clear, enabling the book to be easily read. C. H. S.

Professional Paper. The Interpretation of Topographic Maps. No. 60. By Roland D. Salisbury and Wallace W. Atwood, University of Chicago. U. S. Geological Survey, Government Printing Office, Washington, D. C., 1908.

It was very fortunate for the Geography and Physiography teachers of the United States that these past-masters of Geology brought out this splendid volume. Many teachers are in possession of topographic maps issued by the Government yet are unable to appreciate them to the fullest extent from the fact that they do no understand absolutely what they mean. This work is not alone, however, for teachers of geography and geology, but the layman will find it of much value. The plates which make up the bulk of the volume have been carefully selected from the many maps and folios gotten out by the Government, and each map has been selected to illustrate some particular feature. Taking the volume as a whole, the various geographic and geological features of the United States are brought before the individual. The volume contains seventy-eight pages of texts, and six pages of a complete index. There are seventy plates and thirty-four figures. The first plate is an interesting one, showing the areas covered by the topographical surveys of the Government. The execution of these plates and figures is of the very highest order, and the work is gotten out in a manner such as only the Government can do. As the authors say in the preface, "the volume may be looked upon as a sort of laboratory map manual for use of students." It is a volume that ought to be in the possession of every geography and geology teacher in the United States, and may be secured of the Government.

C. H. S.

Organic Chemistry, including certain portions of Physical Chemistry, for Medical, Pharmaceutical, and Biological Students (with practical exercises), by H. D. Haskins and J. J. R. MacLeod. Pp. 367. John Wiley & Sons, New York. Chapman & Hall, London, 1907.

This book was written with the idea of presenting, in the simplest manner, the facts of organic and physical chemistry which have an essential bearing on medical science.

The first chapter treats of the nature and composition of organic compounds; this is followed by a description of the methods employed for purifying and testing the purity of substances, a description of the methods of elementary analysis; and then a chapter on the principles of physical chemistry as applied to molecular weight determinations and to the theories of osmosis, solution, etc.

The rest of the book includes a description of the various groups of organic substances, and, where possible, there is chosen as the representative of each group somebody of medical or biological importance.

The practical exercises distributed through the text are carefully selected and arranged so as to occupy about four hours of laboratory work per week for thirty weeks. The book appears well adapted to the purpose indicated, is fairly well illustrated, and contains few typographical errors. A. L. S.

Handbuch für Physikalische Schulerubungen von Hermann Hahn. Professor am Dorotheenstädtischen Realgymnasium und Leiter der praktischen Kurse für physikalische Schulerübungen in der Alten Urania zu Berlin. Mit 340 in den Text gedruckten Figuren. Berlin. Verlag von Julius Springer. 1909. Pages, xv+507.

This book is a splendid compilation of Physics experiments for use in secondary schools. There are 211 experiments, most of which are familiar to the older teachers of Physics, yet at the same time there are many new suggestions, telling how the various laws of Physics may be illustrated by new methods. As the author says, "The book is addressed to those teachers of Physics who are fitted by experience and ability to conduct laboratory exercises. The book is suited for young teachers to whom the introduction into the new method of teaching and the arrangement of laboratory exercises play such a heavy part. After the head of the exercise follows a statement of how many pupils are required for carrying out the exercises and how much time is needed for it. After references to the literature comes the list of apparatus and instructions as to how the exercises are to be carried out." In the table of contents we find 21 exercises devoted to Mass and Measurement; 39 to Equilibrium and motion of solid bodies; 14 to motion of solid bodies; 8 to properties of liquids; 2 to the properties of gases; 15 to vibration of wave motions; 7 to Sound; 19 to Heat; 25 to Light; 9 to Magnetism; and 53 to Electricity. The Physics teacher who expects to have the greatest success in his calling must be not only familiar with the literature bearing upon the subject in his own language, but with that in England, France, and Germany as well. To inform him on secondary School physical measurements, there is no better book published than this one, and if the teacher is not able to read German he ought to become familiar with

that language. It is hoped that some American publishing house will see fit to bring out an American translation of this very valuable work.

C. H. S.

Gulick Hygiene Series—Book II, Emergencies, by Charlotte Vetter Gulick, 12 mo. Cloth. iv+174 pages, illustrated. List price, 40 cents. Ginn & Company, Chicago.

In these times when there is such a world-wide movement toward the conservation of our resources and so many efforts being put forth to bring about those conditions which will make the general public health better and conserve the vitality of the individual, this book is very timely. It is well written and is full of helpful suggestions as to what should be done to an injured individual in emergency. This book not only tells what to do in case of an accident, but, what is far more important, perhaps, it tells one how to preserve his health and vitality by avoiding those habits and doing those things which are injurious. As the author says, on information which she secured, "The book has been written on the basis of concrete cases not from theory nor a compilation of what has generally been written in First Aid books." It is a book that should be in the library of every well informed person—those whose aim is to make the world better from every point of view. The illustrations are probably all new and are well executed and to the point. The book is divided into twenty-nine chapters. There are ten pages devoted to questions varying upon the discussions in the text. There is a glossary in which the more uncommon and technical words are defined. The index is complete. Mechanically the book is well made and typographically well done.

C. H. S.

Human Body and Health, By Alvin Davison, Professor of Biology in Lafayette College, Pa. American Book Co., 1908. 8 vo., pp. 320.

The sub-title indicates that the book is "An Elementary Text-Book of Essential Anatomy, Applied Physiology, and Practical Hygiene for Schools." Its size (320 pages) and the simple language bear out the idea that it is for schools below the high school.

Now-a-days one would almost think an author launching a new "elementary" or "secondary" school text-book should have a good reason for one more, added to the large number already in existence. And in this we are not disappointed, for in the usual place (preface) the author says: "The numerous text-books on elementary physiology have largely neglected the discussion of facts relating to public health." Whether we agree with this statement or not, the book is made and will sell.

Of the 25 chapters that make up the book at least half contain much applied physiology, hygiene, and "health maxims." The value of the applied part is that it is generally given in connection, thus being better understood and remembered. Things that strike one while reading through the book are: The special chapter on milk as a food and as carrier of disease; flies, fingers, and the lips as carriers and depositers of germs, on food, books, pencils, and drinking cups. The graphic method of representing these and other facts is well worth mentioning. Whatever historical references are given, and the portraits of Pasteur, Jenner, and Koch are commendable, only, one would

naturally give the greater—Pasteur—the place of honor on the first page. Statistics are very liberally used, and if they do not convince the grammar school pupil they will be good practice in reading numbers, as the author naturally gives the largest he can find. The method of asking questions at the end of the chapters is a very good one, better than giving a summary at the end from which careless pupils frequently prepare a large part of their lesson. "Suggestions to Teachers" are also good.

While the author has generally succeeded well in the use of simple language it is frequently done by condensing to such an extent that clearness is sacrificed. It has led to such odd expressions as "cells eating," "sick cells," "sick eyes;" and "waste flesh," for urea; "carbon dioxide which is a part of the ashes;" "grass carried into the cells of the cow's body," etc. The statement "the oxygen uniting with the *dead tissues,** burns them to ashes so that they may be carried out of the body," is along the same line. The words "stimulus" and "healthy" are several times incorrectly used. This is more important in an elementary book than in a more advanced one, as the pupils are sure to say, "Why, the book says so!"

All of these and other misleading statements can be corrected in a second edition, but it would have been better to apply the author's idea, "knowing how to prevent is worth more than cure."

The press work is well done, both text and figures being clear.

L. M.

*The italics are the reviewer's.

The Freshwater Aquarium and Its Inhabitants (illustrated with photographs), by Otto Eggeling and Frederick Ehrenberg. $2.00. 352 pages. Henry Holt & Co., New York.

The authors of "The Freshwater Aquarium" say in their preface that one of them is a professional aquarist and the other "a very enthusiastic amateur." The experiences of both and the observations of others working along possibly more generally scientific lines have been put together in a very interesting although somewhat expensive book. A book of its scope ought not to cost so much.

The authors regard the aquarium as an object which can be made into an artistic ornament for the home, besides offering excellent opportunities for observing nature.

There are seven chapters in the book: "The Aquarium," "Aquarium Plants," "The Inhabitants of the Aquarium," "The Feeding of the Inmates," "Fish Hatching in the Aquarium," "Fish Maladies," "Implements for the Care and Keeping of the Aquarium."

The chapter on "Aquarium Plants" is especially useful, because most aquaria come to naught or present an ugly appearance on account of the ignorance of the owner of aquatic plants.

Other kinds of fishes than the conventional goldfish have been found by the authors to live well and exhibit interesting habits in captivity. Besides, there are frogs, newts, salamanders, turtles, insects, and snails, which flourish if their fellow captives are selected judiciously. In this chapter a mistake has been made in distinguishing the green newt from the red newt. As the authors seem to have suspected they are one species, the red form being a stage temporarily resident on the land.

As a rule, the habits of the animals are well described, but the frequent "backhanded" sentences throughout the book mar what might be a simple, direct style. Scientists generally are accused of causing painful distortions in his majesty's English, but few, let us hope, are so cruel as to do a thing like this: "Highly ornamental and durable, but rather expensive, is the aquarium with all metal parts nickel-plated, and with a glass, slate, or marble bottom."

This book is undoubtedly a contribution to aquarium literature. What a pity, though, that someone does not write a first-class, inexpensive aquarium book on simple lines for the thousands of young people who become interested in aquaria, and especially for the many who fail. While the prospective writer is about it, he might tell how to keep balanced sea water aquaria even in inland places. H. R. L.

A Text-book of Inorganic Chemistry, by Dr. A. F. Holleman, Professor in the University of Amsterdam. Issued in English in coöperation with Hermon Charles Cooper. Third edition, partly rewritten. 8 vo, viii+502 pages, 81 figures. Cloth, $2.50. New York, John Wiley & Sons; London, Chapman & Hall, 1908.

The present edition represents a revision of the work by both the Dutch author and the American editor. The portions on the phaserule, spectroscopy, radio-activity, iron-carbon system and metal-ammonium compounds have been largely rewritten by the author; while those on colloids, experimental determination of equivalent weights and unity of matter are entirely new. The facts are well chosen and the discussion and generalizations deduced from them are clear and may be readily understood.

The use of differential formulæ in the text need not be an obstacle to the student who is willing to rely upon the author's solution of the equations.

On page 400 occurs the statement, "When emanation is dissolved in a solution of copper nitrate the solution is eventually found to contain sodium and also lithium." This is not supported by sufficient evidence, and chemists generally have not accepted it as a fact. A few typographical errors occur, chiefly transposing of letters; the reference to Fig. 28 (p. 115) should be Fig. 29; Fig. 61 (p. 340) should be Fig. 58; 68 Cal. in the first equation (p. 156) should be 69 Cal., and in the following equation 58.4 Cal. should read 59.4 Cal. This book is uniform with its author's text-book of Organic Chemistry. A. L. S.

The Elements of Hygiene for Schools, by Isabel McIsaac. 172 pages. Price, 60 cents. The Macmillan Company, New York.

This book is compiled by a person eminently qualified both by actual experience in teaching and ability to write such a book. As the author says, "It has been the aim of the Compiler to present the subject of Hygiene in such a way that it might be of practical everyday use to large number of pupils who will have no further opportunity for study of the subject." The chapter on Bacteria may seem to be a little out of place, but the relation of Bacteria to disease, housekeeping, and many industries is of increasing importance. There are chapters devoted to Food and Its Composition, to Air and under this subdivisions, Light, Climate, Ventilation, Heating, and Lighting. There is a chapter

on Soil and Water and one on Sewage and Garbage and one on the Causes of Disease and one on Household and School Hygiene. There is, too, a chapter on Hygiene of Occupation. It is very timely, as the subject is one of vital importance to the nation as a whole. The last chapter on "Disinfection and Quarantine," is an important one. It is a book that all teachers of Physiology and Hygiene should possess. It is also an interesting book for the layman to read. It is full of information and ideas from front to back cover, and it ought to have a large sale. Typographically, it is well gotten out and mechanically well made. C. H. S.

Elementary Forge Practice, by John L. Bacon, Instructor in Forge Work, Lewis Institute, Chicago. 12 mo, x+279 pages. 335 figures, 5×7½ in. Cloth, $1.50. John Wiley & Son, New York City.

This book is now in its second edition, which proves the value of the text. It covers the ground from simple Forge Practice to the most complicated form of Forge Work. It is divided into twelve chapters, there being chapters on: The General Description of Forge and Tools; Welding; Calculation of Stock for Bent Shapes; Resetting, Drawing, and Bending; Simple Forged Work; Calculation of Stock and Making of General Forgings; Steam Hammer Work; Duplicate Work; Metallurgy of Wire and Steel; Tool Steel Work; Tool Forging and Tempering; Miscellaneous Work. It also contains a set of tables of circumferences and areas of circles; one on temperatures to which hardened tools should be heated to proper "drawing temper," table of decimal equivalents of fractions of one inch, and a table of weights of bar steel per linear foot; also a course of exercises in Forge work with drawings. The author believes that the text book should be used to explain principles and give examples, not to give minute explicit directions for making a set of exercises. With the assistance of the large number of drawings and the clear way in which the book is written, one with any inclination for forge work can follow out the directions and become fairly proficient in Forge work in a comparatively short time. The book is well made and printed in large, clear type. It is a work that all people who are engaged in Forge Work should possess. C. H. S.

Principles of Physiology and Hygiene, by George Wells Fitz, M.D. 357 pages. Henry Holt & Co., New York.

One feels very much encouraged after reading Dr. Fitz's "Principles of Physiology and Hygiene." It is evident that the era of the dry anatomical physiology, as well as the day of the much-colored school "doctor's book," are over. In this book there is the scientific, simple, and interesting demonstration of the fact that man is an animal, and more, an organism existing in life-relations with other creatures.

After much experimenting in teaching and in writing and using books, we are coming to see that our success depends more on organization in our method of presentation than on anything else. We can teach pure morphology, the relation of structure and function, the evolutionary process, the principles of physiology, personal hygiene, and civic hygiene all in one course, and make it interesting and effective, if we but select, arrange, and present information with proper attention to

the relative importance of these matters in the lives of people. Unquestionably, Dr. Fitz has done this well in his book.

Any teacher who has kept "first aid" books on his circulating shelf knows how greedily pupils snap up these treasures. In this text book we have perhaps the first satisfactory series of properly related statements of what to do when something is the matter.

A helpful feature of the book is "Experiments and Demonstrations" placed at the ends of chapters. The suggestions contained in these appendices are clearly expressed, and, to the reviewer at least, do not have the forbidding look so characteristic of many laboratory directions. H. R. L.

EDUCATIONAL PRESS ASSOCIATION OF AMERICA.

Officers.

President—John MacDonald, Topeka, Kan.

Vice-Pres.—Henry G. Williams, Athens, O.

Secretary—J. W. Walker, Indianapolis, Ind.

Treasurer—S. Y. Gillan, Milwaukee, Wis.

Executive Committee—Howard A. Gass, Jefferson City, Mo.; Geo. L. Towne, Lincoln, Neb.

Members.

American Education, Albany, N. Y.
American Journal of Education, Milwaukee, Wis.
American Primary Teacher, Boston, Mass.
American School Board Journal, Milwaukee, Wis.
Arkansas School Journal, Little Rock, Ark.
Association Review, Washington, D. C.
Canadian Teacher, Toronto, Can.
Colorado School Journal, Denver, Colo.
Educator-Journal, Indianapolis, Ind.
Florida School Exponent, Gainesville, Fla.
Journal of Education, Boston, Mass.
Kindergarten Review, New York City.
Louisiana School Review, Ruston, La.
Moderator-Topics, Lansing, Mich.
Missouri School Journal, Jefferson City, Mo.
Midland Schools, Des Moines, Ia.
Mississippi School Journal, Jackson, Miss.
Nebraska Teacher, Lincoln, Neb.
North Carolina Journal of Education, Durham, N. C.
Ohio Educational Monthly, Columbus, O.
Ohio Teacher, Athens, O.
Pennsylvania School Journal, Lancaster, Pa.
Popular Educator, Boston, Mass.
Primary Education, Boston, Mass.
Rocky Mountain Educator, Denver, Colo.
School and Home Education, Bloomington, Ill.
School Bulletin, Syracuse, N. Y.
School Education, Minneapolis, Minn.
School Journal, New York, N. Y.
School News, Taylorville, Ill.
School Science and Mathematics, Chicago.
Southern School Journal, Lexington, Ky.
Texas School Magazine, Dallas, Tex.
Western School Journal, Topeka, Kan.
Western Teacher, Milwaukee, Wis.
Wisconsin Journal of Education, Madison.

NOTICE

Of the 1909 meeting of the Central Association of Science and Mathematics Teachers:

The annual meeting of the Central Association of Science and Mathematics Teachers will be held at the University of Chicago on Friday and Saturday, November 26th and 27th, 1909.

Professor T. C. Chamberlin of the University of Chicago, recently returned from a study of educational conditions and institutions of the Chinese Empire, will give an address at the general meeting.

Principal James E. Armstrong of the Englewood High School, Chicago, will give the results of his observation and study of segregated classes in high school work.

Friday evening will be devoted to a report on the Relation of Elementary School Nature Study to Secondary School Science.

The sectional programs will be replete with valuable papers, reports and discussions.

Some copies of the Proceedings of the last meeting of the Association are still available. The Proceedings is a volume of 224 pages containing in full the papers presented at the meeting of November, 1908, together with reports, discussions, etc. It contains reports of the committees on the Unifying of Secondary Mathematics; on Geometry; and on Algebra.

While they last copies of the Proceedings may be obtained at 50 cents each.

Persons engaged in teaching science or mathematics, or in supervising such teaching, are eligible to membership. All such persons are invited to apply for membership. New members will be carried to January, 1911, upon the payment of dues for one year ($2.50). In addition to membership each member will receive without further cost the monthly official journal, "School Science and Mathematics," and a copy of the Proceedings for 1908.

Address all communications to the Secretary-Treasurer, Willis E. Tower, Englewood High School, Chicago, Ill.

IMPORTANT NOTICE

The attention of our patrons is called to the change in the business address of this Journal to 2059 East 72nd Place, Chicago, Ill. The editorial address remains unchanged.